

MODERN Machine Shop

HOWARD CAMPBELL, Editor

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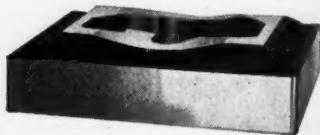
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MODERN Machine Shop

JUNE, 1933

CINCINNATI, OHIO

VOL. 6, No. 1

The Hobbing Process

By M. N. HOUGH

Barber-Colman Company, Rockford, Ill.

ALTHOUGH the hobbing machine is now in quite general use, it is really one of the newer machine tools and the principles upon which it is designed and operated are still somewhat shrouded in mystery. It has taken its place in the majority of well-organized machine shops, but there are many plant operators and executives who, while having jurisdiction over the gear cutting departments, are unfamiliar with the process. Therefore it may be of interest to review the development of the hobbing process and its present-day applications.

Since the development of the hobbing machine has progressed hand-in-hand with the improvements in hob manufacture, both must be considered in making a true analysis of the hobbing process. However, no attempt will be made in this article to explain the theory of gear tooth forms, nor the process by which the correct hob tooth form is obtained. We will confine ourselves to the many applications of the hob, at the same time attempting to show what has been accomplished in the development of machine and hob to more nearly approach present-day standards of accuracy.

There are two fundamental principles of hobbing which it will be well to keep in mind. First, the hob is a

generating tool, the cutting action differing entirely from that of a milling cutter. Second, the hob makes one complete revolution for each division around the periphery of the work. For example; in hobbing a 10-tooth gear, the hob revolves 10 times for each revolution of the gear blank. (The last statement must be qualified when we consider the hobbing of helical gears. This subject will be discussed later.)

It might be well, at this point, to

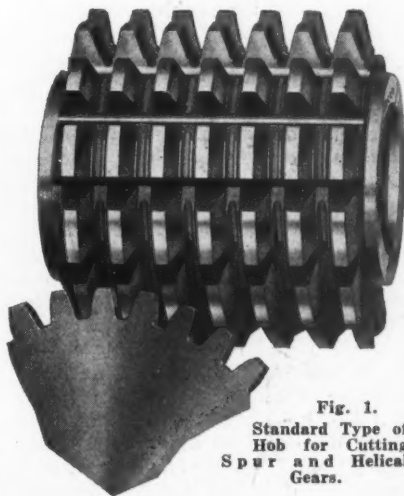


Fig. 1.
Standard Type of
Hob for Cutting
Spur and Helical
Gears.

quote from one hob-maker's catalog: "Hobs can be made to generate almost any form that is equally spaced on a cylindrical base. It is not necessary that the form be symmetrical on an individual axis, but each must be a duplicate of any other or in al-

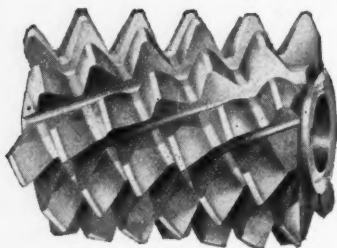


Fig. 2—Hob for Cutting Worm Gears.

ternate groups." One point should be emphasized in this connection; a hob will not produce a single form. In other words, a single key on a shaft cannot be produced by hobbing.

It must be explained here that a thread milling "hob" is not in reality a hob, but is actually a multiple formed milling cutter. A hob, as an accessory of the hobbing machine, must be made with a thread having a definite lead, whereas a so-called thread milling hob cannot be used on a hobbing machine.

As in the case of so many other machine tools, the hobbing machine owes most of the credit for its development to the automotive industry, which was quick to recognize the advantages of the hobbing process as compared with the now almost obsolete automatic gear cutting machine. These advantages are chiefly increased production and more accurate indexing, or spacing. There are machines available which may be even faster than the hobbing machine, but they are by no means as universal in their applications. As far as indexing is concerned, it is the author's impression that the hobbing machine of to-

day is the most accurate commercial machine on the market. We say "commercial" because there are machines which are accurate, such as those used in telescopic work, but the length of time required to produce a gear on one of these machines would be prohibitive in the vast majority of production plants.

A standard type of gear hob is shown in Fig. 1. It is not necessary to make the hob as long as shown, except for gears of very large diameter. However, in average practice the hob illustrated would probably admit of four settings. When a hob is mounted on the spindle of the machine, it is set in such a way that the cutting action will occur as close as possible to one end of the hob. When the teeth that are doing most of the cutting become dull, the hob is shifted along its axis until a new set of teeth is brought into contact with the work. This process is repeated until the teeth have all been used to a point of dullness and the hob requires sharpening. The fact that the hob can be shifted several times before removing from the machine saves considerable set-up time, as each hob that is put onto the machine must be carefully set for depth.

The diameter of a hob is arrived at by considering the size of the hole and depth of form, the latter being determined by the pitch of the tooth that is to be cut. Sufficient stock must be left between the bottom of the gash and the hole to prevent breakage. Having thus decided on a diameter which will provide an ample factor of safety, the length, or face of the hob, is made to the same dimension. Although there is no technical reason for it, hob-makers have standardized on the "square" hob, having the diameter and face of the same dimension, at least for the pitches in most common use.

However, as so often happens, a

rule is made only to be broken and so it is with respect to hob sizes. For example, we may desire a better finish than can be obtained from a standard hob. A standard hob of the pitch in question may be 3 in. diameter with 11 gashes, or 11 rows of teeth. By increasing the diameter to $3\frac{1}{2}$ in., room is provided for 14 gashes. As the hob makes one revolution for each tooth in the gear, or each symmetrical division to be hobbled, it is obvious that each tooth of the hob performs a separate and distinct part of the cutting operation. Thus it is readily seen that if there are 14 teeth in operation at each revolution of the hob, the outline of the gear tooth will be smoother than if the cutting of that same outline were divided between 11 teeth. There are other reasons for variation from standard size, which will be discussed later.

About the time the hobbing machine began to win favor as a production tool, it became apparent that the hob was somewhat deficient as a production tool on account of inaccuracies in form. Almost simultaneously two of the leading hob-makers brought out the "ground" hob, the teeth of which are ground to form after the hob is hardened, and thus any distortion due to hardening is corrected.

The construction of the hob is such that it is extremely difficult to remove all of the inherent faults, largely because of the cam relief and the small amount of clearance for the grinding wheel. However, it was soon found to be comparatively easy to grind the form within satisfactory limits.

To produce a true involute, which is the principle upon which most gear teeth are designed, the teeth of a hob are in the shape of a rack and the side of each tooth is held to a straight line to a limit of plus or minus 0.0002 in. It is considerably more difficult to grind a perfect lead. If

the resultant hob emerges from the grinding operation with a long lead, it will produce a gear with teeth that are thick on the pitch line. Conversely, a short lead will produce a thin tooth. But a still worse condition usually crops in—what is known as "drunken lead." This term simply means that the consecutive teeth in the hob fail to follow a true path. A hob with a "drunken lead" will produce a series of humps and gouges on the gear tooth. The above-noted faults can be practically eliminated, however, by sufficient grinding.

With the advent of the ground finishing hob there was introduced the roughing hob. The latter is considerably cheaper than the former and is designed to cut to the full depth, while leaving approximately 0.012 in. on a side for finishing. This practice is common for pitches ranging from 10 to 6, inclusive. Roughing hobs are generally made with a double thread, which means that they will cut twice as fast as single-thread hobs with the same feed and speed. In some cases it has proved economical to use triple-thread roughing hobs,

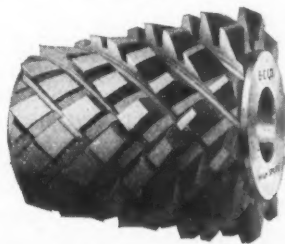


Fig. 3—Hob Used with Tangential Feed.

in which case it is advisable to increase the diameter as otherwise the strain per tooth would be too great.

A very few automotive plants are using ground roughing hobs, claiming that they cut more freely and so outlast the more common, unground hob. Also the ground roughing hob un-

doubtedly leaves a more uniform amount of stock for finishing and so makes for greater accuracy. The majority of users, however, doubt that the advantages of the ground rougher are sufficient to compensate for the greater cost.

Thus far we have considered only the spur gear as a product of the hobbing machine. We are now ready to take up the hobbing of helical gears, or, as they are often erroneously termed, "spiral" gears. In all hobbing machines a mechanical means is provided for feeding the hob across the work on a line parallel to the axis of the work. In all but one make of machine the work remains stationary with respect to the base of the machine and the hob is moved through the work. In either case, the motion is obtained by means of a feed screw. In order to produce a helical gear it is necessary to so change the timing of the work that it will either be retarded or advanced in relation to the revolutions of the hob—retarded for left hand angle and advanced for the right hand.

Although helical gears were produced by the hobbing machine very early in its career, close attention to accuracy was not demanded until the comparatively recent introduction of helical gears into automotive transmissions. In the cutting of helical gears to the limits of accuracy demanded, it soon became apparent that the accuracy of the job depended not alone upon close indexing, but also upon the correctness of the helix angle. And the correctness of the helix angle depends directly upon the accuracy of the feed screw. The importance of having the angles exactly the same in a pair of helical gears cannot be over-estimated. If, for example, the right-hand gear has an angle of 31 deg. 28 min., and the angle of the left-hand gear is 31 deg. 27 min., the very purpose for which

the helical gears are used has been defeated because it is impossible to obtain a true bearing between the two gears. In consequence, the hobbing machine had to be improved to a point that would take care of this important factor.

Although the production of worm gears is very small, as compared with spur and helical gears, the cutting of worm gears is a very important application of the hobbing machine. In fact, it is quite probable that worm gears were cut with hobs before the hobbing machine was invented.

The use of the hob for cutting a worm gear presents some problems not present with other forms of hobbing. Theoretically, the hob used to cut a worm gear must be a duplicate of the corresponding worm as to pitch, length, diameter, and number of threads. However, since the hob is made with a cam relief, the diameter will be reduced with each sharpening. It was discovered that if the hob is smaller in diameter than the worm, it will not produce a satisfactory gear, but the hob can be made slightly larger without affecting the shape or accuracy of the resulting worm gear. It is now standard practice to make the hob enough larger than the worm so that when the hob is worn out, it will still be no smaller than the worm.

This consideration introduces a little trick in setting up the hobbing machine. Since the axis of the worm runs at 90 deg. to the axis of the worm gear, the worm gear hob would ordinarily be set at zero on the hob swivel. But when we increased the hob diameter we also decreased the thread angle, and we must swivel the hob far enough off zero to compensate for the change in thread angle. The angle of setting is decreased slightly each time the hob is sharpened.

The most common method of hobbing a worm gear is to set the

center of the hob, from end to end, opposite the center of the worm gear and sink the hob into the gear until correct depth is reached. However, better results are obtainable by using a tangential feed. In this case the hob is fed, as the name implies, on a line tangent to the pitch diameter of the gear. Figure 2 shows a conventional type of worm gear hob, and Figure 3 shows a tangential feed hob. With the latter, the left side

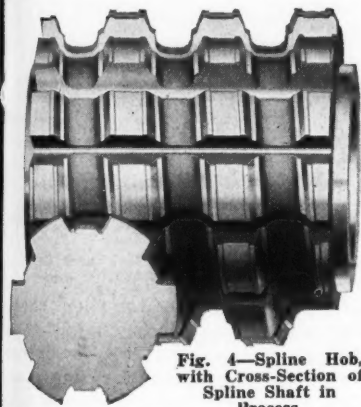


Fig. 4—Spline Hob, with Cross-Section of Spline Shaft in Process.

of the hob enters first and serves as a rougher, the gear being finished as the hob is leaving.

Having disposed of the spur gear, the helical gear, and the worm gear, we are now ready to take up another application of the hobbing process; one which came into use very shortly after the hobbing machine became popular as a production tool. Again the automotive engineer must be given credit for an innovation which has proved a progressive step. The early automobile builder was probably the first manufacturer to recognize the advantages of using more than one key for driving a mating part, and it was an automobile plant official who first suggested hobbing integral keys on a shaft, known as a spline shaft.

A common form of spline shaft is shown in Figure 4. For the benefit of those who may not be familiar with spline shaft hobbing, a word of explanation as to the form of the shaft may be in order. The small lugs at the top of the hob tooth produce the fillets at the base of the key, which might appear to be unnecessary. The mating piece is invariably broached, and it is rather difficult to avoid producing a sharp corner at that point which fits the shaft at the intersection of the key with the root diameter. Since the hob is a generating tool, it will not produce a sharp corner at this point, the amount of radius depending upon the depth of the key. So the corners of the hob teeth are built up into what are called clearance lugs, to produce clearance grooves in the shaft. If the hob is properly made, the sides of the key will be parallel to a point at which the root diameter would intersect the key. The groove also provides clearance for a grinding wheel, in case it is desirable to grind the shaft after hardening, either on the sides of the key or on the root diameter.

The most common form of spline shaft is made with six keys, and this form is used more than any other in transmission construction. Shafts with ten keys are frequently used for propeller shafts, and airplane motor crankshafts usually have 16 or more keys for mounting the propeller hubs.

In machine tool design we often find the four-key or three-key shaft. Whereas it is common practice to finish a spline shaft in one cut, the size of the four and three-key shafts—usually over 2 in. diameter—makes it advisable to take two cuts. In the first operation the hob finishes the sides of the key, cuts the clearance grooves, and leaves 0.010 to 0.015 in.

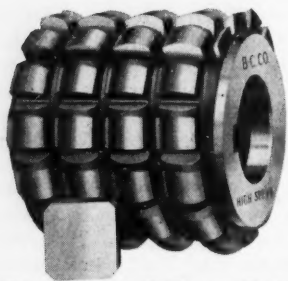


Fig. 5—Square Shafts are Produced with this Hob.

on the root for finishing. A large-diameter hob is then used to finish the root, such a hob having as many as 50 gashes in it so that it will produce a fine finish.

Up to the present time practically all spline shafts have been made with keys having straight and parallel sides, but at this writing many designers are considering seriously the adoption of a key-design with the sides in the form of an involute curve. This change would undoubtedly simplify the task of producing the hobs, as compared with the production of hobs with straight sides, and the change may possibly introduce other advantages.

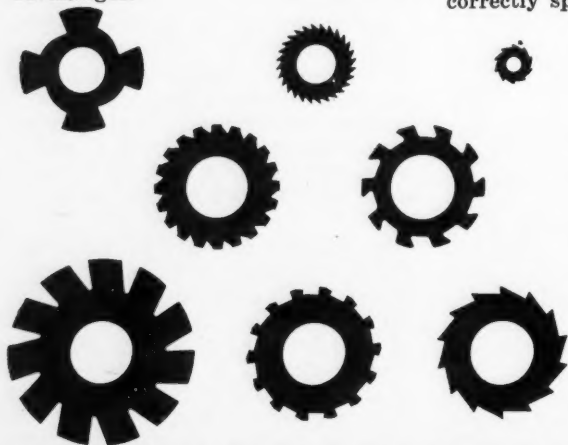


Fig. 7—Some of the forms that are hobbled with the elongated-tooth hob shown in Fig. 6.

An interesting variation of spline shaft hobbing is the hob with which a square shaft is produced. This hob is in the same classification as the spline shaft hob because of the method used in arriving at the form of the hob-tooth. Figure 5 is a good illustration of the difference between the form of the hob-tooth and the form that is generated by it. Other common forms that are produced by

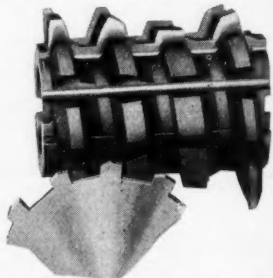


Fig. 6—Elongated-Tooth Hob and Cross-Section of Work.

hobbing are sprockets for silent chain, roller chain and block chain.

A comparatively new type of hob is what is known as the single position hob. This form is used to produce such forms as ratchets, which, correctly speaking, cannot be hobbled.

The hob is in reality a series of formed cutters on a lead, with each succeeding tooth than its predecessor cutting slightly deeper and a single tooth only doing the final finishing. This tooth must be set very accurately with respect to the center line of the work.

A still later development is the elongated-tooth hob, shown in Figure 6. The tool comprises a peculiar combination of a series of hobs and formed milling cutters, al-

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CHANGE TOOLS WITHOUT STOPPING OR SLOWING DOWN THE MACHINE

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Genuine
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"MODERN MAGIC" Chucks give multiple spindle range to single spindle machines. Drills,

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and several operations

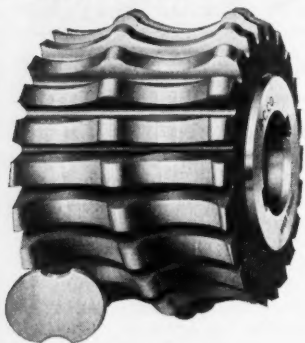
can be performed

without removing

the work.



though it is operated as a conventional hob. It must, however, be set very accurately with respect to the work. Figure 7 illustrates a number of forms which can be hobbled with



Figs. 8 and 9—Special Forms Produced by the Hobbing Process. Fig. 10—Hob for Production of Free-Wheeling Cam, with Cross-Section of Work.

this tool, and which could not be produced with the conventional type of hob.

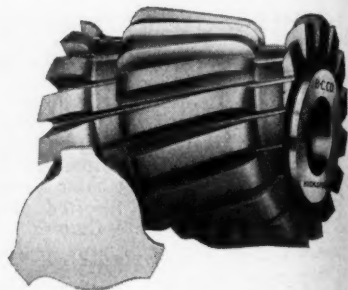
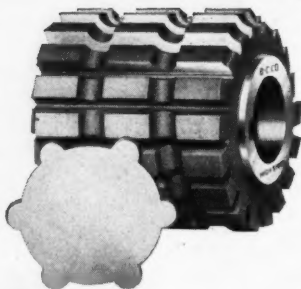
The illustrations Figures 8, 9, 10, 11 and 12 show some of the more freakish forms that are produced by hobbing. Those who are familiar with automotive construction will recognize Figure 10 as an example of a free-wheeling cam. The job indicated as Figure 12 is a striking example of increased efficiency. This piece was formerly done on a milling machine and required four operations to obtain the desired results. A hob was developed which with the piece was completed in one pass. The hobbing time was one-eleventh of the milling time, and a decidedly higher degree of accuracy resulted from the use of the hob.

We will close our discussion with the mention of one more type of hob—the topping hob. For a gear

which transmits a comparatively slow motion and where quietness is not an essential factor, a cheap blank can often be used, cut from bar stock or made from a stamping. The diameter of the blank is left slightly larger than the theoretical diameter of the finished gear, and the hob is made to cut the diameter to size at the same time the teeth are generated. A variation of this is a hob which chamfers the top corners of the keys when hobbing a spline shaft, removing a burr which otherwise would have to be filed off.

A recent development in hobbing machine construction is the tapered hob spindle. For a number of years it has been the practice to make the hole in a ground hob round and

straight to a limit of plus 0.00025, minus 0.000. The hob is supposed to be a good slip fit on the hob spindle but sooner or later the spindle wears and even when new the hob may not run as true as it should. To get the best results from a hob, it



ought to run true—at both ends—to within 0.0002 in. It has been found that by using a spindle with a steep taper it is very much easier to obtain and hold an ideal running condition. This design has the added advantage

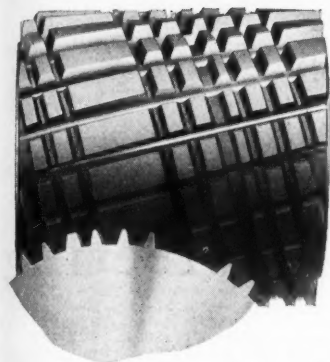


Fig. 11—Hob for Production of Special Ratchet Wheel.

of having the hob mounted on the machine under the same running conditions as obtained when the form was ground, and also when it was inspected.

The latest development in the hobbing field is a machine which will automatically hob a spline shaft with the keys straight and parallel but with the root diameter tapered. See Figures 13 and 14. This machine is entirely special, not simply a standard machine to which a special attachment has been applied, but it is universal in that it will also hob any form which can be handled on the corresponding standard size. In ad-

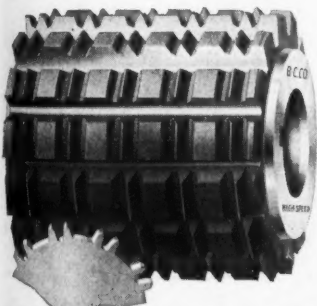
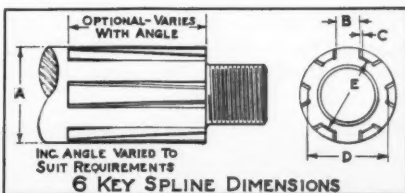
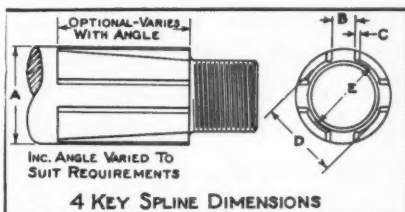


Fig. 12—By changing the method of machining this piece from milling to hobbing, the production time has been reduced to one-eleventh of the former time.

dition to hobbing a tapered spline, it will also cut a helical gear which may have a shaft of the same diameter each side of the gear. An example of this is the gear in the center of a cam shaft for driving the distributor. Another interesting feature of this machine is its ability to hob a worm gear by means of a tangential feed.

The hob required for the tapered spline is very special. Besides being tapered, the design includes a constantly-varying pitch. The amount of taper in the shaft can be varied by gearing in the machine, within reasonable limits.



Figs. 13 and 14—Hobs are now being made with which the keys can be hobbled on a spline shaft so that the keys will be straight and parallel but with the root diameter tapered, as shown in the drawings.

As stated at the beginning of this article, no attempt has been made to delve into technicalities such as gear tooth forms, which is a limitless subject in itself. Neither have we discussed the processes involved in the manufacture of hobs, this article being confined to the use of the tools only. This subject will be taken up later, in a separate article.

...Sit In at this

As guests of "Eddie" Brandt, who has reported this meeting for us, we are permitted to sit in and see what is being done by one of our major industries to normalize conditions through the rehabilitation and modernization of equipment. Mr. Brandt is Manager of the Renewal Parts Division, Westinghouse Electric & Manufacturing Company.

CHAIRMAN: Now fellows, this meeting will be devoted to a discussion of better ways and means

Executives' Meeting

of making our product. The thing to do is to quit talking about the depression, settle down to facts and start getting the shop into condition so that all possible waste will be eliminated. That is the biggest step that can be taken in the direction of normal conditions.

I have seen enough of this panic, for this time; in fact, I thought I had seen enough of this condition in 1913-14 and 1920-21, but here is a real depression. America does everything in a big way, and we sure have a real depression.

I want to say here that I am afraid



Fig. 1 — A machine department in the East Pittsburgh plant of the Westinghouse Electric & Mfg. Co. in 1905. The equipment layout and work-handling methods were considered modern in every respect.

REPAIR PARTS — MADE BY LANDIS

If you are in need of medical attention, you place yourself in charge of a physician. Should you require legal advice, you consult a lawyer. Or, supposing that you contemplate the erection of a new office building, you retain an architect.

Foolish indeed would it be to question the wisdom of such action. It is the only proper thing to do. For the men chosen are by training and experience more highly qualified than any others.

Now to get to the heart of this matter—it is just as logical for the users of Landis grinders to purchase their repair parts from the maker of the machines. For the maker is more highly qualified than any other, both by long training and by a natural desire to render a service that any user has the right to expect.

Repair parts coming to you from Landis bring with them the assurance that the same quality will be found therein as was built into the new machines originally.

LANDIS
REPAIR PARTS

It Pays to Use Genuine Landis Repair Parts

LANDIS TOOL COMPANY
WAYNESBORO PENNSYLVANIA

DETROIT CHICAGO NEWARK PHILADELPHIA



Fig. 2—Railway Control Apparatus Machine Department Before Rearrangement.

some of us are just sitting around at these meetings and are not really taking any action toward modernizing or putting our house in order. It is essential for every department head to do his part and get his department in shape so that on those orders which are starting to come through you will have lower costs, better methods, faster production, and will be able to make quicker deliveries. If you haven't made a survey of your department or haven't started working on plans to handle your work better and faster and at less cost, it's time to get busy.

How many of you fellows have heard about the National Rehabilitation Program which has been promoted by the leading industrialists throughout the country? We don't

nation on the road back toward prosperity. If we don't find some way to make conditions better, they are going to get worse, although it may not be possible for some of us to see how that could happen.

Rehabilitation is the modernizing and bringing up to date of our manufacturing equipment, replacing obsolete equipment, and repairing modern equipment which has become damaged or worn. A machine that is out of repair is losing the company's money. Instead of being an asset, it is an expense. It is not only not returning any interest on the money invested in it, but it is producing at an abnormally high cost—if it is producing at all. Every day that that machine is in crippled condition or is standing idle represents so much dead loss in dollars and cents. The thing to do is to get that machine into condition to turn out its maximum production. If that can't be done, it should be replaced by a modern machine. It's more econom-



Fig. 3—The Railway Control Apparatus Machine Department After Rearrangement. Total Cost of Rehabilitation, \$21,540. Annual Saving Through Increased Facilities, \$21,600.

Fig. 2

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Fig. 4—Panel Assembly Department Before Rearrangement.



ical to spend a thousand dollars for a new machine of modern, up-to-date design and ready for service than to dribble that thousand dollars away, a few dollars every day, through low production at abnormally high costs.

I want to show you some photographs of some of the departments that have been rehabilitated. The superintendents of these departments have been getting their house in order so that they can do an A-1 job. In fact, on the orders that have come through since they organized their departments, they have turned out better jobs than ever before.

Now here is Figure 1; this shows you what we considered a modern, up-to-date shop in 1905. How many of you fellows would like to be running a department or shop like this today? Well, there are a lot of shops no more modern than this one, and yet you say you don't think much of it.

I wish that each one of you department superintendents would make a survey of your department during the next few days and let me have a definite report and recommendation as to what should be done to modernize your shop immediately, bearing in mind that expenses and costs can be reduced by analyzing the following items:

Departmental Supervision
Clerical Labor
Material Handling Labor
Storeroom Help
Defective Workmanship
Losses of Material
Shipping and Traffic Expense
Power Purchased and Generated
Rearrangement of Equipment
Accident Compensation
Fire Insurance and Taxes
Building Depreciation and Rental
Wiring and Lighting Equipment
Heating, Ventilating, and Piping
Maintenance of Machine Motors
and Other Mechanical Equipment
Maintenance of Land, Buildings
and Grounds.

I am going to show you several "before and after" pictures, so that you can make comparisons and to help you develop some ideas as to just what you can do so that your department or shop can stay in busi-



Fig. 5—Panel Assembly Department in New Quarters. Total Cost of Moving and Rehabilitation, \$112,759. Annual Savings, Due to New Arrangement, \$110,266.



Fig. 6—Die Grinding Department Previous to Rearrangement.

ness and meet competition successfully. Competition is becoming keener and will continue to get keener than ever before as business returns.

Figure 2 shows you how one of our departments looked in 1931, and Figure 3 shows you the same department in 1932. You will note that this department is now in A-1 operating shape, with modern, self-contained machine tools, modern over-head lighting and ventilation, and modern conveyors. The material progresses through the department in orderly fashion instead of being scattered all over the floor; accidents have practically been eliminated, and all of the types of expense mentioned before have been reduced on an average of about 20 per cent. It cost \$21,500 to rehabilitate this shop, but the annual savings amount to \$21,600.

Now let me show you what Mr. Smith has done in the last two years in his panel department. Compare Figure 4 with Figure 5. His first consideration was that panel assembly, with all of the modern and up-to-date electrical controls, switches, and so on has to be assembled in sequence of operation and a complete assembly made on the floor so that the customer's tests can be made. His old

could be realized, the savings made through better arrangement of his equipment amount to \$110,266 annually. He now has a department that he is proud to bring his many customers into, and besides he is turning out the best product of its kind that has ever been manufactured.

Now, I don't want you to neglect your tool departments. You all know that jigs, fixtures, and dies are high-priced and that there can be just as much money wasted in the tool departments—and maybe more—than

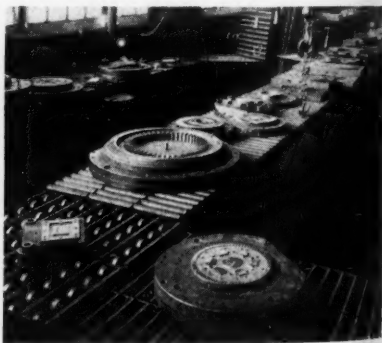


Fig. 7—The dies are rebuilt on the conveyor, saving handling back and forth between benches.

in the manufacturing departments. Compare Figure 6 and Figure 7, which shows what Mr. Griffith has done with his large die department. He has thrown out a lot of old benches and put in a modern conveyor system on which the dies are rebuilt and prepared for the grinding department. Instead of handling the dies from bench to bench with a lot of chain blocks, they are rebuilt right on the conveyor and then travel down to the grinders. The department has been put in first-class order and he paid for the entire move, the rearranging, and new equipment in a year's time by eliminating the hand operations and handling.

* * *

CONCLUSION BY MR. BRANDT

The above report shows what can be accomplished through rehabilitation and it is up to the individual plant executive, whether he is an employer or an employee, to see that the particular section of American industry under his control is modernized in every way possible so that our workmen will have better places in which to work and will be able to produce better products at less cost. The time to do the job is right now, while production demands are still light enough so that the time and equipment can be spared to do the work.

Two of the most important of the factors that contributed to the building of our great American industrial units were faith and courage—faith in the future of America and courage to finance new industries. That same faith and that same courage applied to the rehabilitation of our industries will go along way toward putting this country on its feet again. The important point is—do it now!

Do not forget that we have had depressions before and we will have them again. We will come out of this one as we have come out of the others; in fact, we are slowly emerg-

ing now, and it is likely that within a year or so our industrial equipment will be taxed to capacity by the demands of production.

Tips from an "Old Timer"

A tight belt will result eventually in a worn bearing.

Chalk rubbed on a taper shank will help to prevent it from working loose.

When working cast iron in the lathe, all excess oil should be wiped from the ways and chuck-screws.

A double end helical end-mill can be ground in the ordinary tool grinder by building up the ends of the mill with hard solder and then centering in a collet or bench lathe.

An old mechanic says that steel balls make excellent broaches for the sizing of holes, and a set should be included in every toolmaker's kit. The balls can be purchased at any mill supply house and should be selected either exact size or 0.0005 in. under-size.

An arbor press, especially if it is air-operated, will serve admirably to try out the smaller bending and forming dies. It saves the time of setting up the die and avoids tying up the try-out press.

Commercial Centerless Grinding Service

The Commercial Centerless Grinding Co., 6538 Carnegie Ave., Cleveland, Ohio, is engaging in the commercial grinding of parts by the centerless method. The service consists of grinding straight, taper, shoulder or formed parts in both large and small quantities.

The most progressive manufacturer can give you the best service. The manufacturers represented here are among the leaders in their industry; patronize them and mention MODERN MACHINE SHOP when doing so.

Simplified Method of Plant Stores Control

By RALPH E. WESTON

MODERN methods of scientific stores-control demand that the stores-keeper shall be compelled to make a physical count of all material and supplies coming into stores. Experience has proved conclusively that where this count is not insisted upon,

there exists always the danger of a careless stores-keeper's accepting the statements of quantities as shown on the delivery slip and on the stores copy of the purchase order and certifying to the receipt of these quantities without making a physical count.

PURCHASE-REQUISITION				Indicate this on all bills etc.	
To.....				Ord. No.	
Address.....				Date	
Please furnish)				Contract No.	
Deliver to).....				Reg'n No.	
For (organization unit).....					
NOTICE TO VENDORS Invoice in Duplicate must be sent promptly to the organization stated above. All goods or services must be billed at agreed price which shall include delivery charges unless otherwise specified. No claim is legally valid if not authorized at this form.					
	QUANTITY	UNIT	DESCRIPTION	UNIT PRICE	AMOUNT
<div style="display: flex; justify-content: space-between;"> <div> Signed..... Approved..... Purchasing Agent </div> <div> Requisitioning Officer Signed..... Department Head </div> </div>					
Original			This Copy for Vendor		

Duplicate

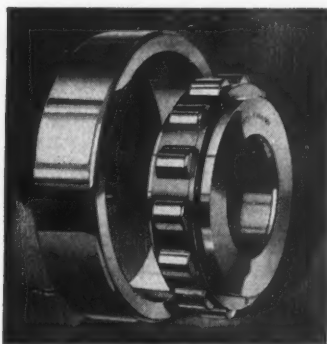
To be Retained by Purchasing Agent

Quintuplicate

For Requisitioning Officer's Files

Combined Purchase-Requisition Receiving Slip, all prepared at one writing

WHERE NO OTHER TYPE OF BEARING WILL

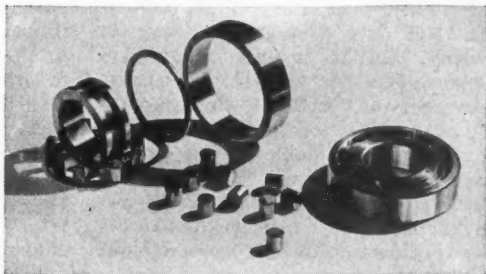


STAND UP

Because of Extreme Load Conditions, Use
PRECISION ROLLER BEARINGS
With the Heavy Bronze Cage

Picture to yourself the most difficult load conditions a bearing can be called upon to meet—high speed, heavy load, temporary overloads, shock, vibration. Then read, in the adjoining column, how NORMA-HOFFMANN Precision Roller Bearings—time-tested heavy-duty units—meet these conditions.

And remember—PRECISION Roller Bearings interchange in size with all standard ball bearings. They can be had—in addition to the standard type here illustrated—in one-lip, two-lip (self-contained), full roller type (without cage), self-aligning and adapter types.



"NORMA-HOFFMANN" **PRECISION BEARINGS** **BALL, ROLLER AND THRUST**

NORMA-HOFFMANN BEARINGS CORPORATION, STAMFORD, CONN., U. S. A.

PARALLEL LINE CONTACT

Solid cylindrical rollers between cylindrical races providing maximum load contact area, increased steady load capacity, and a larger shock-absorbing capacity than any other type of single-row bearing.

SAFETY FACTOR

A margin ample for temporary overloads up to 50% beyond normal rating, as under peak loads, in unusually severe duty, or under shock conditions.

SUPERIOR CAGE

Made of extruded bronze to secure maximum density and uniformity—machined all over for balance—riding on inner ring lands or shoulders, relieving the rolling elements of its weight.

EXTREME ACCURACY

Rollers held to .0001 inch on diameter and to .0003 inch on length, throughout—absolutely true rolling surfaces, ends absolutely square with the sides—highly finished, quiet, friction-free.

DURABILITY

Uniform contact throughout the length of the rollers, providing the most efficient load distribution—greater wear-resisting surfaces—true rolling between all load contact areas—minimum friction between roller and cage.

SPEED QUALITIES

A lower friction coefficient under heavy load than any other type of bearing—speed ability equal to that of any ball bearing, size for size, up to 35,000 R.P.M.

There's no duty too hard for a PRECISION Roller Bearing. And, for the less exacting duties, there are PRECISION Ball and Thrust Bearings. Write for the Catalog—or ask our engineers for suggestions.

CERTIFICATE OF RECEIPT OF MATERIAL																	
To.....					Ord. No.												
Address.....					Date												
Please furnish) Deliver to).....					Contract No.												
For (organization unit).....					Reg'n No.												
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DESCRIPTION																	
<p>To Dept. Head—</p> <p>The above goods have this day been received in proper condition: (or services satisfactorily performed) in accordance with requirements, unless otherwise indicated.</p> <p>Date..... Signed.....</p> <p style="text-align: right;">Receiving Clerk</p>																	
Triplicate to Storeskeeper—From Store Clerk to Accounting Dept.																	
Quadruplicate to be Returned to Requisitioning Officer																	

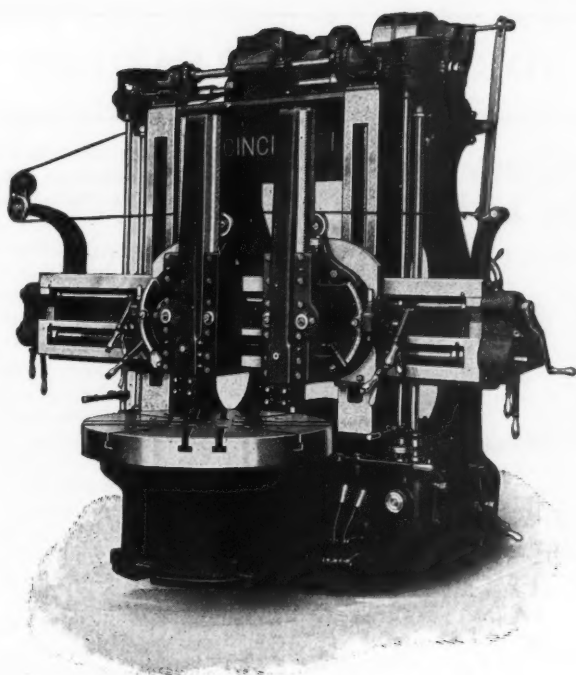
Combined Form of Purchase-Requisition and Receiving Slip

The advantage of using a copy of the purchase requisition or order as a receiving slip, to be signed and returned by the stores-keeper upon receipt of the goods specified, is obvious. Not only does it save time in writing, but it insures a uniform nomenclature for everything ordered, delivered, and received—which is very important. But the problem has been to retain this valuable feature and at the same time insure that a proper check would be made of goods received. At least it took on the aspects of a problem in so far as our plant was concerned.

As is often the case, the simplest method was overlooked while we searched diligently for some method whereby the desired result could be achieved. Eventually, however, the obvious came to our attention and we found that the stores-keeper could be

forced to make a physical count of materials received through the simple expedient of leaving off the quantity ordered from the stores copy of the purchase order. With no indication of the amount ordered, he would have to make the desired count in order to properly receipt for the materials. And this, we found, could be done by cutting out that part of the sheet of carbon paper which transmitted the writing on the original order to the store copies. The store copies are the triplicate, which is sent to the accounting department upon receipt of goods ordered, and the quadruplicate, which is returned to the order department.

Not only did the method outlined effectually solve the problem, but it also eliminated the necessity for shortening certain sheets in the set and thus saved on the printing bills.



A Modern Tool . . . The Cincinnati Boring Mill

ANY USER of the Cincinnati Boring Mill will tell you that it is a thoroughly modern tool. Incorporated in its design are modern features which improve your production and cut your costs. Some of these features are:

Centralized Control—All control levers are operated from one central position.

Rapid Power Traverse—Speeds up production without additional physical effort.

Feed Gear Box Mechanism—Is entirely independent for each head. There are eight feeds provided.

All Gears and Racks are of Steel—To insure long, dependable service and low maintenance costs.

Built in various sizes from 5 feet to 12 feet to meet all requirements.

SEND FOR BULLETIN!

THE CINCINNATI PLANER COMPANY
3100 SOUTH STREET CINCINNATI, OHIO

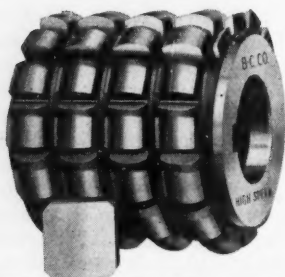


Fig. 5—Square Shafts are Produced with this Hob.

on the root for finishing. A large-diameter hob is then used to finish the root, such a hob having as many as 50 gashes in it so that it will produce a fine finish.

Up to the present time practically all spline shafts have been made with keys having straight and parallel sides, but at this writing many designers are considering seriously the adoption of a key-design with the sides in the form of an involute curve. This change would undoubtedly simplify the task of producing the hobs, as compared with the production of hobs with straight sides, and the change may possibly introduce other advantages.

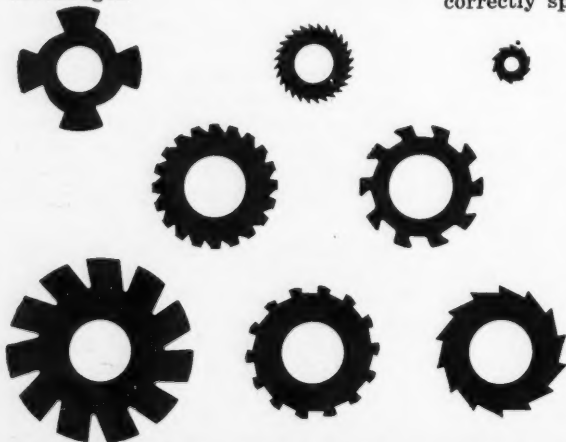


Fig. 7—Some of the forms that are hobbled with the elongated-tooth hob shown in Fig. 6.

An interesting variation of spline shaft hobbing is the hob with which a square shaft is produced. This hob is in the same classification as the spline shaft hob because of the method used in arriving at the form of the hob-tooth. Figure 5 is a good illustration of the difference between the form of the hob-tooth and the form that is generated by it. Other common forms that are produced by

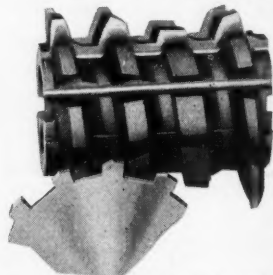


Fig. 6—Elongated-Tooth Hob and Cross-Section of Work.

hobbing are sprockets for silent chain, roller chain and block chain.

A comparatively new type of hob is what is known as the single position hob. This form is used to produce such forms as ratchets, which, correctly speaking, cannot be hobbled.

The hob is in reality a series of formed cutters on a lead, with each succeeding tooth than its predecessor cutting slightly deeper and a single tooth only doing the final finishing. This tooth must be set very accurately with respect to the center line of the work.

A still later development is the elongated-tooth hob, shown in Figure 6. The tool comprises a peculiar combination of a series of hobs and formed milling cutters, al-

CHANGE TOOLS WITHOUT STOPPING OR SLOWING DOWN THE MACHINE

**insist
on the
Genuine**

**"Modern
Magic"**

The original and only genuine "MODERN MAGIC" Chucks and Collets are manufactured exclusively by the Modern Tool Works. Insist on having the genuine tool that is saving time and money in both large and small shops everywhere. Look for the name "MODERN MAGIC" on chucks and collets.

OTHER MODERN PRODUCTS

Self Opening Die Heads (Stationary and Revolving Types)

Solid Adjustable Die Heads

Adjustable Hollow Milling Tools

Collapsible Taps

Friction Tap Collets

Self Opening

Stud Setters

Tapping Attachments

Threading Machines

Chaser Grinders

Inserted Blade Milling Cutters

"MODERN MAGIC" Chucks keep revolving spindle machines producing all the time. Tool changes made while the machine is running at cutting speed—No stopping—

No slowing down. Changes from drill to reamer to tap instantaneously and safely made with one hand.

"MODERN MAGIC" Chucks give multiple spindle range to single spindle machines. Drills, reamers, counterbores, taps, etc., are all accommodated and several operations can be performed without removing the work.



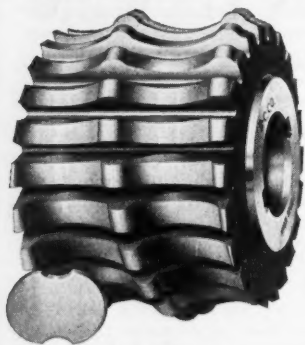
CATALOGS SENT UPON REQUEST

MODERN TOOL WORKS

Rochester, N. Y., U. S. A.

Division of Consolidated Machine Tool Corporation of America

though it is operated as a conventional hob. It must, however, be set very accurately with respect to the work. Figure 7 illustrates a number of forms which can be hobbled with



Figs. 8 and 9—Special Forms Produced by the Hobbing Process. Fig. 10—Hob for Production of Free-Wheeling Cam, with Cross-Section of Work.

this tool, and which could not be produced with the conventional type of hob.

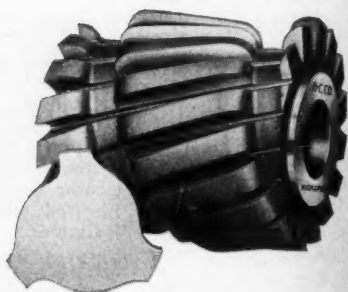
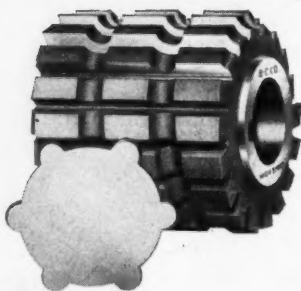
The illustrations Figures 8, 9, 10, 11 and 12 show some of the more freakish forms that are produced by hobbing. Those who are familiar with automotive construction will recognize Figure 10 as an example of a free-wheeling cam. The job indicated as Figure 12 is a striking example of increased efficiency. This piece was formerly done on a milling machine and required four operations to obtain the desired results. A hob was developed which with the piece was completed in one pass. The hobbing time was one-eleventh of the milling time, and a decidedly higher degree of accuracy resulted from the use of the hob.

We will close our discussion with the mention of one more type of hob—the topping hob. For a gear

which transmits a comparatively slow motion and where quietness is not an essential factor, a cheap blank can often be used, cut from bar stock or made from a stamping. The diameter of the blank is left slightly larger than the theoretical diameter of the finished gear, and the hob is made to cut the diameter to size at the same time the teeth are generated. A variation of this is a hob which chamfers the top corners of the keys when hobbing a spline shaft, removing a burr which otherwise would have to be filed off.

A recent development in hobbing machine construction is the tapered hob spindle. For a number of years it has been the practice to make the hole in a ground hob round and

straight to a limit of plus 0.00025, minus 0.000. The hob is supposed to be a good slip fit on the hob spindle but sooner or later the spindle wears and even when new the hob may not run as true as it should. To get the best results from a hob, it



ought to run true—at both ends—to within 0.0002 in. It has been found that by using a spindle with a steep taper it is very much easier to obtain and hold an ideal running condition. This design has the added advantage

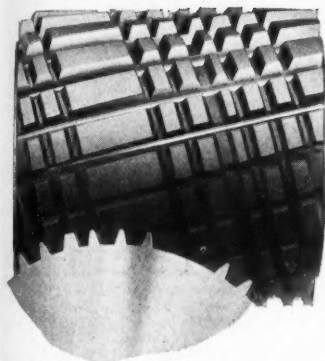


Fig. 11—Hob for Production of Special Ratchet Wheel.

of having the hob mounted on the machine under the same running conditions as obtained when the form was ground, and also when it was inspected.

The latest development in the hobbing field is a machine which will automatically hob a spline shaft with the keys straight and parallel but with the root diameter tapered. See Figures 13 and 14. This machine is entirely special, not simply a standard machine to which a special attachment has been applied, but it is universal in that it will also hob any form which can be handled on the corresponding standard size. In ad-

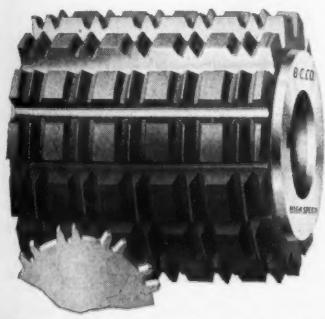
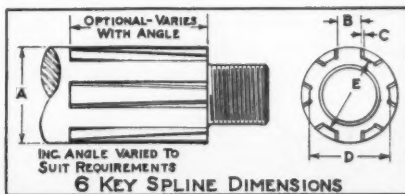
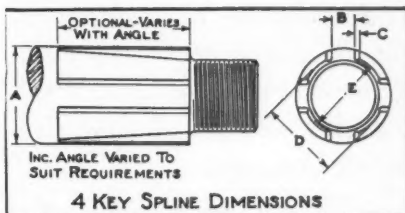


Fig. 12—By changing the method of machining this piece from milling to hobbing, the production time has been reduced to one-eleventh of the former time.

dition to hobbing a tapered spline, it will also cut a helical gear which may have a shaft of the same diameter each side of the gear. An example of this is the gear in the center of a cam shaft for driving the distributor. Another interesting feature of this machine is its ability to hob a worm gear by means of a tangential feed.

The hob required for the tapered spline is very special. Besides being tapered, the design includes a constantly-varying pitch. The amount of taper in the shaft can be varied by gearing in the machine, within reasonable limits.



Figs. 13 and 14—Hobs are now being made with which the keys can be hobbled on a spline shaft so that the keys will be straight and parallel but with the root diameter tapered, as shown in the drawings.

As stated at the beginning of this article, no attempt has been made to delve into technicalities such as gear tooth forms, which is a limitless subject in itself. Neither have we discussed the processes involved in the manufacture of hobs, this article being confined to the use of the tools only. This subject will be taken up later, in a separate article.

...Sit In at this

As guests of "Eddie" Brandt, who has reported this meeting for us, we are permitted to sit in and see what is being done by one of our major industries to normalize conditions through the rehabilitation and modernization of equipment. Mr. Brandt is Manager of the Renewal Parts Division, Westinghouse Electric & Manufacturing Company.

CHAIRMAN: Now fellows, this meeting will be devoted to a discussion of better ways and means

Executives' Meeting

of making our product. The thing to do is to quit talking about the depression, settle down to facts and start getting the shop into condition so that all possible waste will be eliminated. That is the biggest step that can be taken in the direction of normal conditions.

I have seen enough of this panic, for this time; in fact, I thought I had seen enough of this condition in 1913-14 and 1920-21, but here is a real depression. America does everything in a big way, and we sure have a real depression.

I want to say here that I am afraid



Fig. 1—A machine department in the East Pittsburgh plant of the Westinghouse Electric & Mfg. Co. in 1905. The equipment layout and work-handling methods were considered modern in every respect.

REPAIR PARTS — MADE BY LANDIS

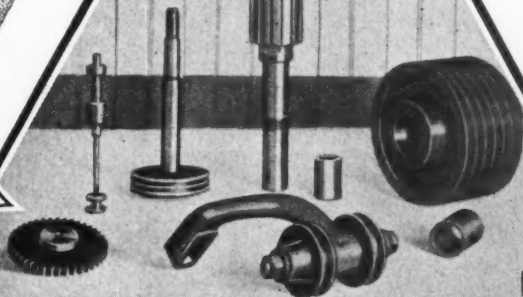
If you are in need of medical attention, you place yourself in charge of a physician. Should you require legal advice, you consult a lawyer. Or, supposing that you contemplate the erection of a new office building, you retain an architect.

Foolish indeed would it be to question the wisdom of such action. It is the only proper thing to do. For the men chosen are by training and experience more highly qualified than any others.

Now to get to the heart of this matter—it is just as logical for the users of Landis grinders to purchase their repair parts from the maker of the machines. For the maker is more highly qualified than any other, both by long training and by a natural desire to render a service that any user has the right to expect.

Repair parts coming to you from Landis bring with them the assurance that the same quality will be found therein as was built into the new machines originally.

LANDIS
REPAIR PARTS



It Pays to Use Genuine Landis Repair Parts

LANDIS TOOL COMPANY
WAYNESBORO PENNSYLVANIA

DETROIT

CHICAGO

NEWARK

PHILADELPHIA



Fig. 2—Railway Control Apparatus Machine Department Before Rearrangement.

some of us are just sitting around at these meetings and are not really taking any action toward modernizing or putting our house in order. It is essential for every department head to do his part and get his department in shape so that on those orders which are starting to come through you will have lower costs, better methods, faster production, and will be able to make quicker deliveries. If you haven't made a survey of your department or haven't started working on plans to handle your work better and faster and at less cost, it's time to get busy.

How many of you fellows have heard about the National Rehabilitation Program which has been promoted by the leading industrialists throughout the country? We don't

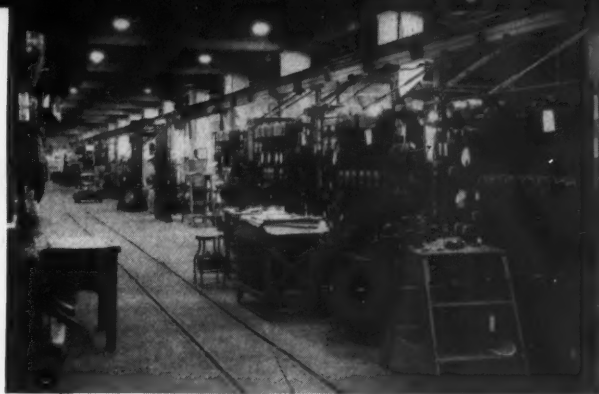
nation on the road back toward prosperity. If we don't find some way to make conditions better, they are going to get worse, although it may not be possible for some of us to see how that could happen.

Rehabilitation is the modernizing and bringing up to date of our manufacturing equipment, replacing obsolete equipment, and repairing modern equipment which has become damaged or worn. A machine that is out of repair is losing the company's money. Instead of being an asset, it is an expense. It is not only not returning any interest on the money invested in it, but it is producing at an abnormally high cost—if it is producing at all. Every day that that machine is in crippled condition or is standing idle represents so much dead loss in dollars and cents. The thing to do is to get that machine into condition to turn out its maximum production. If that can't be done, it should be replaced by a modern machine. It's more econom-



Fig. 3—The Railway Control Apparatus Machine Department After Rearrangement. Total Cost of Rehabilitation, \$21,500. Annual Saving Through Increased Facilities, \$21,600.

Fig. 4—Panel Assembly Department Before Rearrangement.



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Fig. 5—Panel Assembly Department in New Quarters. Total Cost of Moving and Rehabilitation, \$112,759. Annual Savings, Due to New Arrangement, \$110,266.

Control
Department
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Fig. 6—Die Grinding Department Previous to Rearrangement.

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Now let me show you what Mr. Smith has done in the last two years in his panel department. Compare Figure 4 with Figure 5. His first consideration was that panel assembly, with all of the modern and up-to-date electrical controls, switches, and so on has to be assembled in sequence of operation and a complete assembly made on the floor so that the customer's tests can be made. His old

could be realized, the savings made through better arrangement of his equipment amount to \$110,266 annually. He now has a department that he is proud to bring his many customers into, and besides he is turning out the best product of its kind that has ever been manufactured.

Now, I don't want you to neglect your tool departments. You all know that jigs, fixtures, and dies are high-priced and that there can be just as much money wasted in the tool departments—and maybe more—than

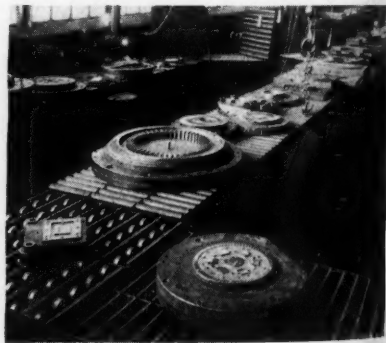


Fig. 7—The dies are rebuilt on the conveyor, saving handling back and forth between benches.

in the manufacturing departments. Compare Figure 6 and Figure 7, which shows what Mr. Griffith has done with his large die department. He has thrown out a lot of old benches and put in a modern conveyor system on which the dies are rebuilt and prepared for the grinding department. Instead of handling the dies from bench to bench with a lot of chain blocks, they are rebuilt right on the conveyor and then travel down to the grinders. The department has been put in first-class order and he paid for the entire move, the rearranging, and new equipment in a year's time by eliminating the hand operations and handling.

* * *

CONCLUSION BY MR. BRANDT

The above report shows what can be accomplished through rehabilitation and it is up to the individual plant executive, whether he is an employer or an employee, to see that the particular section of American industry under his control is modernized in every way possible so that our workmen will have better places in which to work and will be able to produce better products at less cost. The time to do the job is right now, while production demands are still light enough so that the time and equipment can be spared to do the work.

Two of the most important of the factors that contributed to the building of our great American industrial units were faith and courage—faith in the future of America and courage to finance new industries. That same faith and that same courage applied to the rehabilitation of our industries will go along way toward putting this country on its feet again. The important point is—do it now!

Do not forget that we have had depressions before and we will have them again. We will come out of this one as we have come out of the others; in fact, we are slowly emerg-

ing now, and it is likely that within a year or so our industrial equipment will be taxed to capacity by the demands of production.

Tips from an "Old Timer"

A tight belt will result eventually in a worn bearing.

Chalk rubbed on a taper shank will help to prevent it from working loose.

When working cast iron in the lathe, all excess oil should be wiped from the ways and chuck-screws.

A double end helical end-mill can be ground in the ordinary tool grinder by building up the ends of the mill with hard solder and then centering in a collet or bench lathe.

An old mechanic says that steel balls make excellent broaches for the sizing of holes, and a set should be included in every toolmaker's kit. The balls can be purchased at any mill supply house and should be selected either exact size or 0.0005 in. under-size.

An arbor press, especially if it is air-operated, will serve admirably to try out the smaller bending and forming dies. It saves the time of setting up the die and avoids tying up the try-out press.

Commercial Centerless Grinding Service

The Commercial Centerless Grinding Co., 6538 Carnegie Ave., Cleveland, Ohio, is engaging in the commercial grinding of parts by the centerless method. The service consists of grinding straight, taper, shoulder or formed parts in both large and small quantities.

The most progressive manufacturer can give you the best service. The manufacturers represented here are among the leaders in their industry; patronize them and mention MODERN MACHINE SHOP when doing so.

Simplified Method of Plant Stores Control

By RALPH E. WESTON

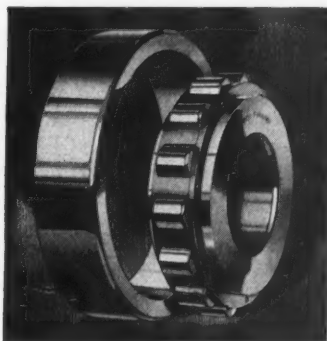
MODERN methods of scientific stores-control demand that the stores-keeper shall be compelled to make a physical count of all material and supplies coming into stores. Experience has proved conclusively that where this count is not insisted upon,

there exists always the danger of a careless stores-keeper's accepting the statements of quantities as shown on the delivery slip and on the stores copy of the purchase order and certifying to the receipt of these quantities without making a physical count.

PURCHASE-REQUISITION					
To.....			Indicate this on all bills etc.		
Address.....			Ord. No.		
Please furnish) Deliver to).....			Date		
For (organization unit).....			Contract No.		
			Reg'n No.		
NOTICE TO VENDORS Invoice in Duplicate must be sent promptly to the organization stated above. All goods or services must be billed at agreed price which shall include delivery charges unless otherwise specified. No claim is legally valid if not authorized at this form.					
	QUANTITY	UNIT	DESCRIPTION	UNIT PRICE	AMOUNT
Approved..... <div style="text-align: center;">Purchasing Agent</div>			Signed..... <div style="text-align: center;">Requisitioning Officer</div>		
Original.....			Signed..... <div style="text-align: center;">Department Head</div>		
This Copy for Vendor					
Duplicate To be Retained by Purchasing Agent					
Quintuplicate For Requisitioning Officer's Files					

Combined Purchase-Requisition Receiving Slip, all prepared at one writing

WHERE NO OTHER TYPE OF BEARING WILL



STAND UP

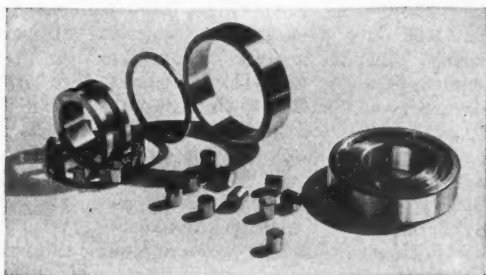
Because of Extreme Load Conditions, Use

PRECISION ROLLER BEARINGS

With the Heavy Bronze Cage

Picture to yourself the most difficult load conditions a bearing can be called upon to meet—high speed, heavy load, temporary overloads, shock, vibration. Then read, in the adjoining column, how NORMA-HOFFMANN Precision Roller Bearings—time-tested heavy-duty units—meet these conditions.

And remember—PRECISION Roller Bearings interchange in size with all standard ball bearings. They can be had—in addition to the standard type here illustrated—in one-lip, two-lip (self-contained), full roller type (without cage), self-aligning and adapter types.



PARALLEL LINE CONTACT

Solid cylindrical rollers between cylindrical races providing maximum load contact area, increased steady load capacity, and a larger shock-absorbing capacity than any other type of single-row bearing.

SAFETY FACTOR

A margin ample for temporary overloads up to 50% beyond normal rating, as under peak loads, in unusually severe duty, or under shock conditions.

SUPERIOR CAGE

Made of extruded bronze to secure maximum ductility and uniformity—machined all over for balance—riding on inner ring lands or shoulders, relieving the rolling elements of its weight.

EXTREME ACCURACY

Rollers held to .0001 inch on diameter and to .0005 inch on length, throughout—absolutely true rolling surfaces, ends absolutely square with the sides—highly finished, quiet, friction-free.

DURABILITY

Uniform contact throughout the length of the rollers, providing the most efficient load distribution—greater wear-resisting surfaces—true rolling between all load contact areas—minimum friction between roller and cage.

SPEED QUALITIES

A lower friction coefficient under heavy load than any other type of bearing—a speed ability equal to that of any ball bearing, size for size, up to 35,000 R.P.M.

There's no duty too hard for a PRECISION Roller Bearing. And, for the less exacting duties, there are PRECISION Ball and Thrust Bearings. Write for the Catalog—or ask our engineers for suggestions.

NORMA-HOFFMANN

PRECISION BEARINGS

BALL, ROLLER AND THRUST

NORMA-HOFFMANN BEARINGS CORPORATION, STAMFORD, CONN., U. S. A.

CERTIFICATE OF RECEIPT OF MATERIAL																								
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DESCRIPTION																								
To Dept. Head— The above goods have this day been received in proper condition: (or services satisfactorily performed) in accordance with requirements, unless otherwise indicated. Date..... Signed..... <div style="text-align: right; padding-right: 50px;">Receiving Clerk</div>																								
Triplicate to Storeskeeper—From Store Clerk to Accounting Dept.																								
Quadruplicate to be Returned to Requisitioning Officer																								

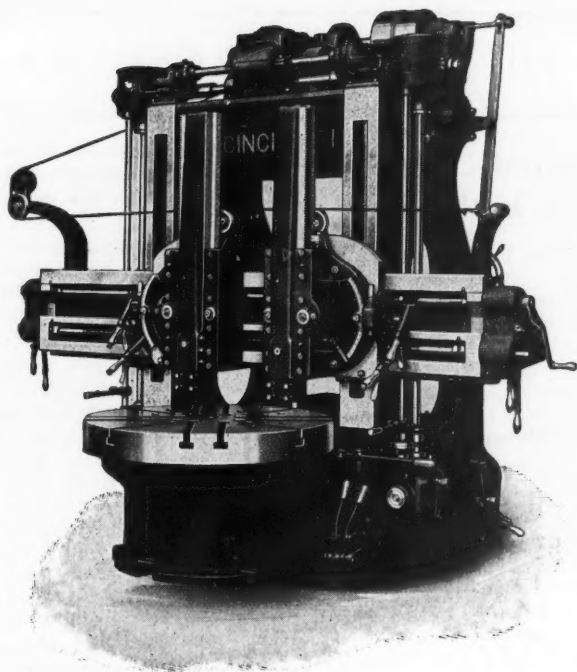
Combined Form of Purchase-Requisition and Receiving Slip

The advantage of using a copy of the purchase requisition or order as a receiving slip, to be signed and returned by the stores-keeper upon receipt of the goods specified, is obvious. Not only does it save time in writing, but it insures a uniform nomenclature for everything ordered, delivered, and received—which is very important. But the problem has been to retain this valuable feature and at the same time insure that a proper check would be made of goods received. At least it took on the aspects of a problem in so far as our plant was concerned.

As is often the case, the simplest method was overlooked while we searched diligently for some method whereby the desired result could be achieved. Eventually, however, the obvious came to our attention and we found that the stores-keeper could be

forced to make a physical count of materials received through the simple expedient of leaving off the quantity ordered from the stores copy of the purchase order. With no indication of the amount ordered, he would have to make the desired count in order to properly receipt for the materials. And this, we found, could be done by cutting out that part of the sheet of carbon paper which transmitted the writing on the original order to the store copies. The store copies are the triplicate, which is sent to the accounting department upon receipt of goods ordered, and the quadruplicate, which is returned to the order department.

Not only did the method outlined effectually solve the problem, but it also eliminated the necessity for shortening certain sheets in the set and thus saved on the printing bills.



A Modern Tool . . .

The Cincinnati Boring Mill

ANY USER of the Cincinnati Boring Mill will tell you that it is a thoroughly modern tool. Incorporated in its design are modern features which improve your production and cut your costs. Some of these features are:

Centralized Control—All control levers are operated from one central position.

Rapid Power Traverse—Speeds up production without additional physical effort.

Feed Gear Box Mechanism—Is entirely independent for each head. There are eight feeds provided.

All Gears and Racks are of Steel—To insure long, dependable service and low maintenance costs.

Built in various sizes from 5 feet to 12 feet to meet all requirements.

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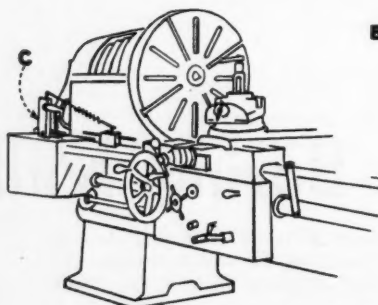
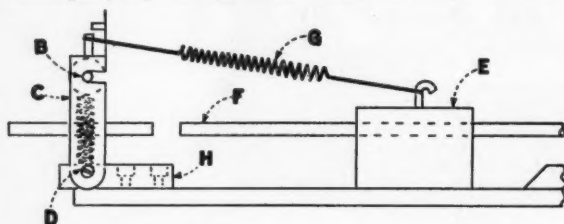
CINCINNATI, OHIO

☞ IDEAS FROM READERS ☞

Automatic Stop for Lathe

By PETER L. BUDWITZ

AN easily-made automatic stop for use with the regular power feed on an engine lathe is shown in the accompanying illustration. One of



Details of Automatic Stop for Engine Lathe

these stops was attached to each lathe in a battery that is in use in the production department. The lathes are of the type that is in common use, having the change gear lever A at the side of the headstock.

The change gear lever is located over a plate in such position that an index pin in the lever can drop into any one of three holes in the plate, according to whether the operator

wishes to use the feed toward the headstock, reverse, or leave it in neutral. To attach the device, the index pin is removed from the change gear lever, then a $\frac{1}{4}$ -in. hole is drilled into the end of the lever handle and a pin is driven into it as shown at B. To a small steel block H is attached a catch C by means of a screw D, upon which the catch swivels. An elongated

slot is provided in the catch to engage the pin B, thus keeping the gears properly meshed while the operation is in process.

At a point on the lathe-bed some eight or ten inches from the block H is attached the block E, through which slides the rod F, as shown. Provision is made for anchoring one end of the spring G to the block; the other end of the spring is attached to a pin in the top of the catch C. A spring I attached to the under side of the lever handle A tends to pull it downward, and the pin J stops the lever handle, when the handle

is released, and holds it in neutral position.

In operation, as the carriage feeds toward the headstock it contacts the rod F, the opposite end of which strikes catch C and forces it backward until it is disengaged from the pin B. When released, the pin B is pulled downward by the spring G until it strikes the stop-pin J, thus automatically cutting off the feed.

If an adjustable stop is desired, a hole may be drilled through the catch C for an auxiliary rod which can be anchored by means of a setscrew in any desired position. The device worked so well that it was found possible for one operator to tend several lathes simultaneously. The mechanism functions perfectly; as soon as the catch is tripped the gear shift lever jumps into neutral position with the aid of the running gears and the spring, without any clattering of gears.

Grinding Attachment for Planer in Locomotive Shop

BY H. H. HENSON

EVERYTHING possible is being done these days to improve the performance of the steam locomotive and increase the time between shop-pings. In one middle-west shop a method has been developed by which the shoe and wedge faces of driving boxes are both planed and surface ground without removing the boxes from the planer. The machine used is the planer shown in Fig. 1, and the

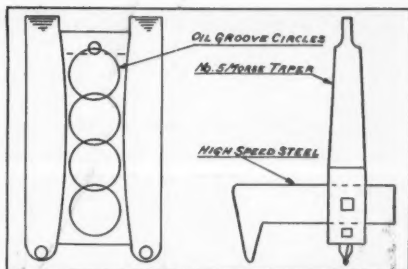


Fig. 2—(Left) Drawing showing how oil-grooves are cut in shoe and wedge faces. (Right) Diagram of tool with which oil-grooves are cut.

grinding operation is performed with a grinding attachment that is bolted to the tool-block, using the four tool-clamping bolts, as shown in the illustration.

Before the boxes are set up for this operation, all drilling and plugging of the journal brasses was completed and the oil grooves are cut in the shoe and wedge faces with the aid of the tool illustrated in the drawing Fig. 2. The cutter in the oil grooving tool is adjustable to accommodate the various widths of shoe and wedge faces and so that the oil groove circles may be cut to the correct diameters. These operations are intended to provide for perfect lubrication of the shoe and wedge faces, thus reducing friction and wear, improving the riding qualities, and prolonging the life of all wearing parts.

To finish the shoe and wedge faces, the boxes are clamped onto the planer table on two parallel jigs or fixtures such as are commonly

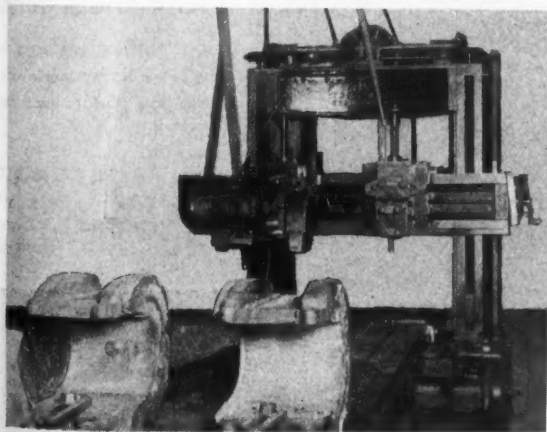
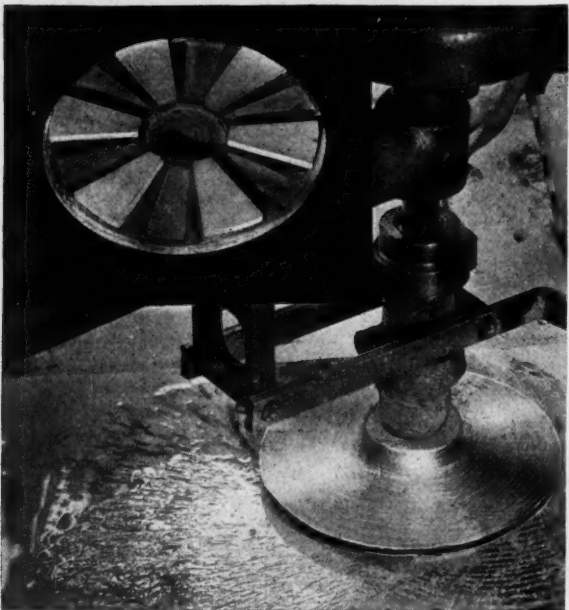


Fig. 1—Planer with Grinding Attachment for Finishing Shoe and Wedge Faces on Driving Boxes.



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job just as careful
selected. They are
shape, in abrasive
grade.

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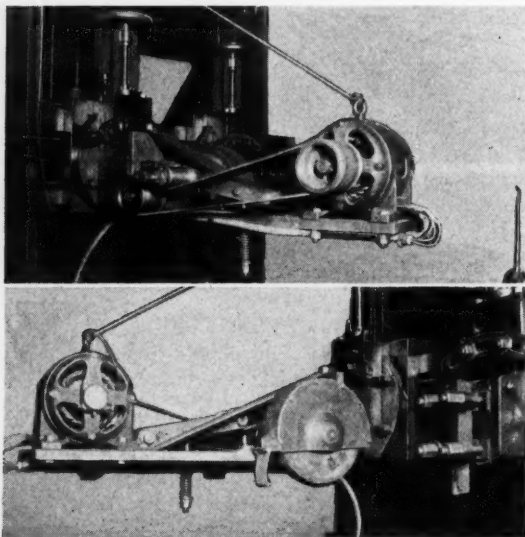


Fig. 3—Right and Left Hand Sides of Grinding Attachment

used for this purpose. The faces are then rough planed, using a coarse feed. The head carrying the grinder is then shifted into position and the faces are finished by grinding.

The surface grinder, shown in Fig. 3, is a very efficient tool, being powered by a five horsepower motor which drives the grinding wheel spindle through the medium of a four-inch belt. The pulleys are 36 in. between centers. The wheel spindle is ball bearing, $1\frac{1}{8}$ in. in diameter, and runs at a speed of 1,900 r.p.m. The grinding wheel is 16 in. in diameter, with a 3 in. face.

In addition to grinding the shoe and wedge faces of driving boxes, the grinding attachment can be used to grind other flat surface work, such as locomotive guides, slide valves, and so on. The switch by which the grinding wheel motor is controlled is placed on the bed of the machine in close proximity to the operator's position, so

that perfect control is available at all times.

The parts necessary can be made in the toolroom at a nominal cost, and a motor applicable for the job may be had at a reasonable price. The attachment will soon pay for itself through the improved quality of the work.

The advantages of the better fits and finishes of ground surfaces are becoming more apparent every day, and the grinder has become a popular tool in the railway shop. Grinding attachments can be adapted to many kinds of metal-working machines.

An Improved Screw Driver for Assembly Operations

BY GEORGE HENRY FISHER

IN the manufacture of small electrical and mechanical products, assembly usually accounts for a large percentage of the cost. If holding fixtures are used for keeping parts in alignment during assembly, most of the operator's time is spent, as a rule, in loading and unloading the fixtures. Moreover, such fixtures represent a considerable amount of expense for design, construction, and maintenance.

In a large electrical manufacturing plant in Chicago, where hundreds of thousands of small screws are used daily in assembling, a study was made of this class of work in an attempt to eliminate some of the holding fixtures. Analysis of the jobs brought out some

enlightening facts. In the first place, it was noted that, for the most part, fixtures were necessary only because



When small parts were assembled by the method formerly in use, the work was held in a fixture and the operator used both hands to operate the screw driver. The operation was both difficult and slow.

both of the operator's hands were required to operate the screw driver, which was of the spiral automatic type. It was at once apparent that if one of the operator's hands could be freed from the screw driver, it could be used to hold the work and the fixture could be done away with.

When the spiral of the ordinary spiral automatic screw driver is extended, the tool measures close to $1\frac{1}{2}$ feet in length. With the right hand on the handle, it is virtually impossible to seat the blade of the tool into the slot of a small screw without assistance from the left hand. And at the end of the working stroke, the left hand is again required for holding the blade down and in position during the upward, or recoil, stroke. We saw that if it were possible for the operator to grasp the tool at a point closer to the blade, the tool would be brought

into balance for one-hand manipulation. But in order to achieve this objective, it would be necessary to have a screw driver which would not only be properly balanced, but also of the spiral type and so designed that the mechanism would return the blade to its extended position.

Among the various types of spiral screw drivers is one so designed that a spiral compression spring, encased in the handle, automatically returns the tool to its extended position as soon as the driving power is relaxed. We obtained one of these drivers and removed the wooden handle, care being taken not to damage the mechanism. An $8\frac{1}{2}$ -in. length of light seamless brass tubing, of a diameter that would provide a snug fit on the ratchet mechanism of the tool, was selected for the handle. At a point $3\frac{1}{4}$ in. from one end of the tubing a hole was drilled, just large enough to



Using the re-designed screw driver. The operator holds the work with one hand and drives the screws with the other, gripping the tubular handle at the lower end.

permit the passage of the small screw which holds the ratchet housing in place. Beginning at a point $\frac{1}{4}$ in.

from the center of the screw hole, toward the nearer end of the tubing, a lateral, rectangular hole was cut, $\frac{1}{2}$ in. wide and $\frac{3}{4}$ in. long, to allow access to the knurled thumb-lug which controls the ratchet mech-



The screw driver as it looks with the tubular handle removed.

anism. A brass washer, the inside diameter of which was a snug fit over the tubing and the outside diameter $1\frac{1}{4}$ in., was soldered to the end of the tubing closest to the holes and the handle was ready for use.

The small screw that holds the ratchet housing in place was then removed from the screw driver, care being taken not to disarrange the rather intricate ratchet mechanism within, and the tubing was fitted onto the driver. In doing so it was essential to avoid shifting the ratchet housing (which, of course, was now loose) lest the ratchet dogs become dislodged. Just below the ratchet encasement is a knurled collar which is used for locking the spiral. The ratchet housing seats against this collar, thus allowing the housing to slide only in

one direction—away from the collar. So to prevent slipping of the housing, the handle end of the driver was inserted into the end of the tubing supporting the washer. The tapped hole in the ratchet encasement was brought into line with the drilled hole in the tubing, and the small screw was replaced. The thumb-lug fitted nicely into the aperture made for it.

The large screw in the handle end of the tool, the function of which is to retain the spiral compression spring, was removed and a nickel-plated washer was slipped under its head. The washer was a close fit inside the tubing, and functioned to keep the axis of the driver in line with that of the tubing, thus allowing clearance for the chuck as it reciprocates in and out of its sleeve.

The operator grasps the driver as he would a pencil, holding it near the lower end and driving the screws with one hand while he holds the work with the other. Not only has the job been speeded up, but the expense of designing and making a large number of assembling fixtures has been eliminated. And last—but by no means least—the task has been made much easier for the operator.

A Simple Method of Testing Lubricating Oils

By W. F. SCHAPHORST

LUBRICATING oils are used in many plants where facilities for making tests of the various kinds, grades, and makes of oils are lacking. In such cases the purchaser has to depend entirely upon the word of the supplier, judge the qualities of the oils from the prices, or repeat his order for oils that have proved more or less satisfactory in the past.

However, here are five simple and

understandable tests for determining comparative values of lubricating oils. The essential qualities of such oils are staying power, film strength, and lubricity. The staying qualities, or ability to adhere, can be demonstrated by the first and second tests. The third test is used to determine resistance to shock, such as is received when a sudden load is applied to a bearing. The fourth and fifth tests will give a fairly accurate idea of the lubricity, or actual lubricating qualities. No laboratory equipment whatever is needed to make these tests.

1. Moisten the thumb and forefinger with the lubricant. Open and close the finger and thumb, and note how the oil adheres. Its adhering property, or "stickiness", is an indication as to whether or not it will run out of the bearing. Adherence is an important quality in bearing lubricating oil.

2. Put equal-size drops of two or more oils having the same viscosity on a glass plate. Tip the plate to a slanting position. The oil showing the greatest resistance to gravity is preferable.

3. Put on a flat, smooth steel surface equal-size drops of two or more oils having the same viscosity. Hit each drop with a hammer and note how easily the oil is flattened and how much it splatters. The oil that splatters least is preferable, as it is most likely to prevent metal-to-metal contact under severe shock loads.

4. Put a small quantity of the oil in the palm of one hand and rub vigorously with the other. A clear, thin film of oil should adhere to all surfaces touched, and should not rub away. There should also be an absence of frictional heat.

5. Put the lubricant into a wide-mouth container. Dip a wide, flat piece of sheet metal into the oil and then lift it above the container to a height of from 12 to 18 inches and note the

manner in which the oil flows from the plate. The ordinary grade of mineral oil will flow from the plate rapidly, and will splash and splatter. A first-class lubricant will flow off in the form of an even film, and will neither splash nor splatter.

Correct lubrication is important. More than one machine costing thousands of dollars has been ruined through want of a quarter's worth of oil. Further, the oil should be carefully selected for the type of bearing in which it is to be used. It is obvious that heavy cylinder oil should not be used to lubricate a high speed grinding spindle, and it would be just as ridiculous to attempt to use a fine grade of expensive spindle oil in a steam engine. These examples are extremes, but the necessity for selecting oils according to the size, weight, and speed of the journals is more important than most buyers suppose. Believe it or not, it is more economical to buy good lubricating oil than it is to periodically replace worn-out bearings and damaged shafts or spindles.

To drive an automobile at a speed of 106 miles an hour, 230 horsepower is required. The same speed can be obtained with 70 horsepower if the car is streamlined, according to Dr. Oskar G. Tietjens, Westinghouse research engineer. An airplane needs 140 horsepower to do 106 miles an hour, but as water resistance is 800 times that of air, a speed boat requires 4,000 horsepower to make the same speed.

Westinghouse engineers say that the modern electric locomotive has 20 speeds forward and 20 reverse, with maximum velocity of 90 miles an hour in either direction. All speeds are controlled by means of one little handle in the left hand of the operator.

Over the Editor's Desk

Government In Business

SOME poet has said that "men are boys grown tall." Meaning that although the individual has grown to larger physical proportions, his conduct and method of thinking are governed by the same principles that guided his actions when he was in grammar school. And we have been reminded, of late months, that the leaders of many of our national industries are these same boys.

When a boy is standing well with his teacher and his chums, he "feels his oats." He doesn't want to be tied to mother's apron-strings. Doesn't want to have to go to bed early. Doesn't want to eat spinach. Wants to be his own boss. But when he gets into trouble, or needs some money to buy a baseball glove, or gets the stomach-ache as a result of eating unripe apples, then mother and her sympathetic words and ministering hand are his first thought.

And so it has been with a number of our industries. When everything was running like clock-work and the captains were making money in large and satisfying quantities, they wanted industry to be completely emancipated from government. No government in business. But when things turned bad and they began to have the financial belly-ache, they hot-footed it to the government and pleaded for remedies—mostly in the nature of tariffs, subsidies, or regulations.

Undoubtedly they have needed the aforesaid remedies—perhaps drastic ones—and they are about to get them. Not from the "representatives of the pee-pul" in Congress, however; the best thing our Congressmen have done is to demonstrate the utter lack of intelligence with which the people

of this nation select their Congressmen. Congress for a period of four years has concerned itself largely with politics and the building of political fences, and has fiddled generally while Rome burned.

The manner in which the people showed their impatience last fall has, however, compelled some action and as Congress neither knows what to do nor how to do it, it has abdicated its rights and powers and transferred both to the President. And the present Chief Executive has demonstrated his ability to see farther and think clearer than all of Congress put together. He has gone at the job in the manner of one who knows what he is about. He has administered some bitter pills, but at least he has accomplished something. In fact, he has gotten more action in forty days than Congress did in four years, and it is very apparent that he has just started.

The President has asked for and received certain powers, among which is full power to inflate the currency. No inflation has taken place as yet, but the anticipation of inflation alone has had a salutary effect upon business. A certain amount of lethargy exists, however, due to the fear of over-production and cut-throat competition of the price-cutting variety. To eliminate these evils, the President has appointed an "administrator of industry" and has backed legislation which will have the effect of nullifying the Sherman anti-trust law so as to permit the making of wage and production agreements.

What effect such legislation will have upon business and economic conditions may be gathered from the opinions of Henry I. Harriman, Pres-

ident of the Chamber of Commerce of the United States, who may be said to represent the employers of this country, and William Green, President of the American Federation of Labor, who very clearly represents the workers. Mr. Harriman has expressed the opinion that the wages of 10,000,000 men will be raised within six months after the enactment of this bill, and Mr. Green estimates that 4,000,000 persons now idle will be put to work as a direct result of the public works program and the new co-operation between trade units.

The Sherman "anti-trust" law served its purpose, but its day is done. The general interpretation of free and open competition has fostered unfair business methods, cut-throat prices, and general chaos, all of which have in many instances reduced the return on invested capital to the vanishing point. And reduction of the number of working hours with an increase in wages can only be accomplished if prices are sufficiently high to enable the manufacturer to cover the cost of production and leave him a profit.

It is evident that we are upon the threshold of a new industrial and economic era. The time has come when industry must accept a certain amount of regulation, mainly to force a vicious minority to observe the same standards of conduct that are observed by the more ethical majority.

We are about to get a large-size dose of "government in business," and once it is in, it will probably be in to stay. It is much easier to get government into business than it is to get it out again. Still, if government in business is a good thing in bad times, it may be just as much of a good thing in good times and we may yet see the units of the various industries co-ordinated and operating with the efficiency of a modern production plant.



It's easy to control machine speeds or rates of production in any units desired by installing

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THEY provide an effective check against both destructive high speeds by piece workers—an uneconomical lowering of speed by wage workers.

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NEW SHOP EQUIPMENT

Landis Type C Hydraulic Universal Grinder

The Landis Tool Company, Waynesboro, Pa., has brought out a "manufacturing universal grinder" to be known as the Landis 14-in. Type C Hydraulic Universal Grinder. The outstanding feature of the machine is flexibility, which is most important in a universal grinder, but the machine was designed also to meet all requirements of a manufacturing grinder.

The machine has more than ample weight. For instance, the 14x36-in. size weighs 7650 pounds net, without electric motors. The weight has been added, however, at points where the need for rigidity and wearing area are needed, such as in the diameter of the spindles, oversize swivel platens, and larger slides and ways. The grinding wheel base is heavy and rigid. The spindle, which is extra large, is driven by multiple V belts. Landis babbitt-lined steel back bearings are used, and are lubricated by means of filtered oil from an oil pump driven by the spindle itself.

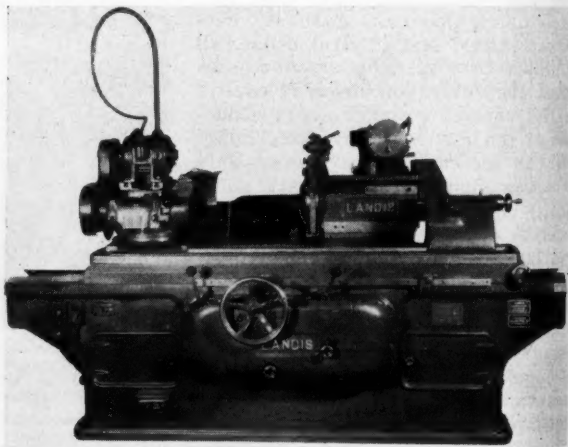
An exclusive Landis feature is the double cylinder type hydraulic table traversing mechanism, the design of which assures absolute smoothness of table traversal and reversal at all speeds. The practically infinite number of table speeds in connection with the stout multi-speed headstock enables the operator to select a combination of work and table speeds ideally suited to the job in hand.

The headstock is fully universal and may be swiveled as far as 90 deg. for face grinding. The wheel base may also be swiveled 90 deg. either side of center and is equipped with a sub-slide so that the head may be

moved forward or back as the nature of the work requires.

An important feature of the design is the accessibility of the various mechanisms for adjustments, inspection, or repair. Removal of the large cover at the front of the bed exposes all control mechanisms and pipe connections. The pump mounting at the rear of the bed is also easily accessible.

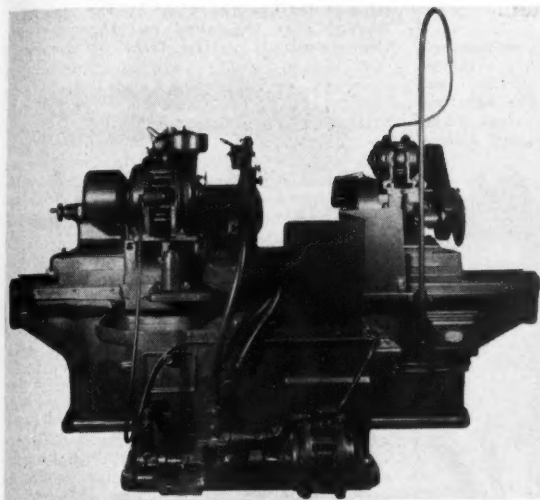
Standard equipment includes such universal features as an anti-friction bearing type internal grinding fixture, a chuck for internal and face grinding, an automatic hydraulic



Landis Type C Hydraulic Universal Grinder

wheel feed mechanism, a center rest, and stationary and traveling cutter tooth rests. Special equipment such as rotary magnetic chucks and loose cam grinding heads may be supplied. Because of the great flexibility of hydraulic power, special hydraulically-operated tooling could be applied to the machine without difficulty and at a cost not prohibitive.

The machine is available in 14-in. swing only and in three lengths, 36, 48, and 72 in. The 48-in. machine weighs 8450 lb. and the 72-in. machine weighs 10,000 lb. A $\frac{3}{4}$ h.p.



Rear View of Machine, Showing Hydraulic Unit

work drive motor is used, a 1 h.p. pump drive motor and a 5 h.p. wheel drive motor. All motors are dynamically balanced and are of the constant speed type.

manufacturer states that the time for setting up the machine averages ten minutes, and that the production speed is approximately 110 gears or pinions per hour.

Bilgram Chamfering Machine

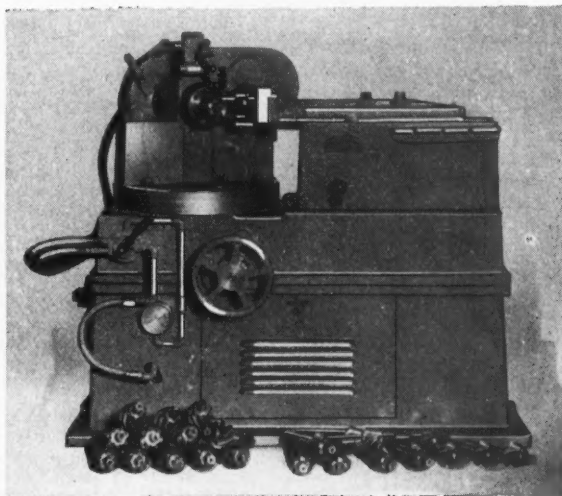
A machine especially adapted for the chamfering of the teeth of spiral bevel gears, but which may also be used to chamfer other types of gears, has been brought out by Bilgram Gear & Machine Works, 1225 Spring Garden St., Philadelphia, Pa. In the cutting of a spiral bevel gear, a feather-edge is left on one side of the tooth which, if not removed before the hardening, is liable to crack off and may cause serious damage. The Bilgram machine removes the feather-edge, eliminating necessity for hand work.

The machine is of the box type, no mechanism being

exposed to dust or grit. At the same time, every part is easily accessible. The machine is intended primarily for production work. The tool head on the front of the ram is equipped with two tools, making it possible to chamfer both ends of one tooth at each stroke. The chuck for holding the gears is of simple design and is operated either by compressed air or by hydraulic power.

The headstock is adjustable to any angle from zero to 90 degrees. Gears up to 18 in. in diameter, irrespective of the number of teeth and pinions with as few as five teeth can be chamfered at production speed. One shot lubrication is available as required.

Ample power for the task is provided by a 2 h.p. motor. The weight of the machine is 2500 pounds. The



Bilgram Gear Chamfering Machine

Baker Contour Grinder

To meet the demand for a machine for the rapid, economical, and accurate grinding of irregular contours or shapes, the machine shown in the illustration has been developed by Baker Brothers, Inc., Toledo, Ohio. The machine is of compact but rugged design,

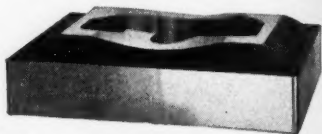


Baker Contour Grinder

and is intended to produce within the finest limits of accuracy and economy.

The machine is vertical in type, and consists primarily of a column with the work

table at the top, the wheel spindle also being vertical with the wheel at the upper end. The spindle is driven from a vertically-



Sample of Internal Grinding Job done on Baker Contour Grinder.

mounted motor which is well protected against dirt or grit. The armature of the wheel spindle motor reciprocates, imparting a reciprocating action to the grinding wheel and thus not only prevents shoulders from forming on the wheel but also provides better cutting action with longer wheel wear. The reciprocating movement is obtained by means of a cam mounted directly below the spindle, which is actuated by an independent motor that is instantly controlled. This feature conserves the life of the wheel and results in perfect work on radius, contour, sweep, or straight die work, or on the grinding of other classes of work which would be impossible without the reciprocating wheel feature.

The table is located at a convenient working height, and can be tilted to any desired angle in relation to the wheel for angle grinding. A pointer is provided for accuracy. As the table clears the mechanism and other parts of the machine, the size of the work that can be handled is practically unlimited.

Standard wheels are used, four wheels with arbors being furnished as standard equipment for each machine. The wheels can easily and quickly be changed, as they are mounted in a specially-designed quick change chuck. Wheels of special shape can be furnished as required.

A wheel dresser with diamond-mounted nib is furnished as standard equipment, the attachment being so designed that it can be quickly mounted in a T slot in the table. With the wheel rotating in a fixed position, the table carrying the dresser is moved up and down by means of a capstan handle. A hand screw attachment is provided to feed the diamond into the wheel.

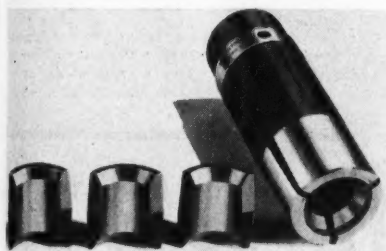
No change in the machine is necessary for internal or external grinding, as the work is simply lifted over the wheel for internal grinding and pressed against it for external grinding. The work is visible at all times. The machine is furnished in the motor-driven type only, and will operate on either 110 or 220 volt circuit. Cord is supplied ready to plug in, or it can be wired in conduit.

The No. 2 size machine, shown in the illustration, has a capacity for wheels of from $\frac{1}{2}$ in. to 4 in. diameter and 2 in. face. The

diameter of the table is 15 in. and the maximum distance from the table surface to the floor is 45 in. The table can be set at an angle of 10 degrees each side of center. The speed of the spindle is 3500 r.p.m. and the total reciprocation movement of the spindle is $\frac{1}{8}$ in. A $\frac{1}{4}$ h.p. motor is used for the main drive. The weight of the machine is 350 pounds. Standard equipment includes the necessary wrenches and tools, a diamond dresser and wrench, two cup wheels and mountings and two mounted face wheels.

Sutton Style L Master Feed Finger

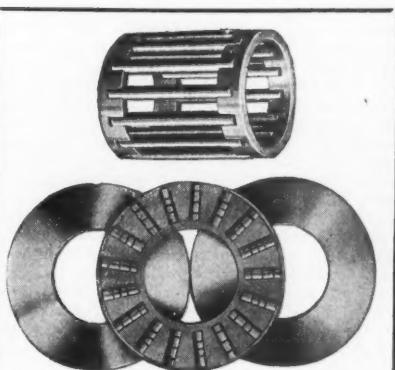
A feed finger designed with interchangeable and replaceable pads, yet of simple and practical design and sturdy construction, is now being offered by the Sutton Tool Co., 2840 West Grand Blvd., Detroit, Michigan. The pads that grip the work are seated in a recess in the master, a generous shoulder at



Sutton Style L Master Feed Finger

either end of the recess being provided to hold the pads positive and take the operating thrust. The pads are prevented from rotating by a pin on the inside of the master which engages a blind hole in one of the pads. There is ample clearance between the pin and the hole so that none of the thrust falls on the pin.

A long taper at the rear end of the pad brings the extreme end of the pad flush with the inside diameter of the master, the forward end of the taper being up to stock diameter. This taper, in combination with the recess, removes all possibility of the bar jamming against the ends of the pad when the machine is being stocked. Each pad is made with a double angle on each side, thus making it possible to bring a worn pad back to size. When long service has worn the hole size of the pads, the points of the angles can be ground down so that the tension of the master will bring the pads together. A wide, firm grip on the stock is assured by the number



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of splits and pads that are used; above $\frac{7}{8}$ in. capacity size the master is split three times, and above the $2\frac{1}{2}$ in. capacity, four times. Three pads are used in the three-split master and four pads in the four-split master.

The maximum of efficiency is assured by the construction and heat treatment. The master is made separate from the gripping pads, the pads being made of steel having special wearing qualities, and the master being made of a high grade of spring steel. Each part is given the heat treatment that will best equip it for its task. An added advantage is possible as a result of this design, in that pads of bronze or cast iron can be used on finished stock or other work that may not be scratched or marred. Pads can easily be removed from the master by spreading the slots, using a special "spreader" which is furnished.

Sutton Style L Feed Fingers are so designed that they will handle a range of stock practically up to machine capacity. Each different make of machine requires its own master, but pads are interchangeable from one master to another of the same size. When pads are worn out, new pads may be applied to the original master, thus reducing the investment in feeders. Standard pads can be furnished for handling round, hex, or square stock.

Alnor Pyro Point Surface Temperature Pyrometer

In order to eliminate the necessity for two or more surface type pyrometers to meet the requirements of rubber plant, paper mill, or other work, the Illinois Testing Laboratories, Inc., 146 West Austin Ave., Chicago, Ill., has brought out the "Alnor Pyro Point" Surface Temperature Pyrometer shown in the illustration. By using the Alnor Pyro Point, it is said that as many as five entirely different styles of thermo-couples can be used with the same instrument, as follows

Form P—Production type for metallic surfaces, such as bearings.

Form B—Mold type for either metallic or non-metallic surfaces such as molds, platens, plates, brick walls, and so on.

Form S—Needle point type for tires, plastic rubber, or similar material where temperature under the surface is desired.

Form R—Ribbon type for revolving rolls or cylinders.

Form W—Welded type for taking temperature of liquids, gases, or any similar application.

The Alnor Pyro Point is a self-contained instrument weighing about two pounds with the thermo-couple. It has a removable arm which supports the thermo-couple. This arm

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Exceptional speed of Bosch Electric Screw Driver cuts production time, reduces power consumption, introduces new economies in production. Exclusive features: Overload clutch . . . Light weight (only $3\frac{3}{4}$ lbs.) . . . Precision center balance, insuring freedom from fatigue, and greater accuracy and speed. Saves money whether on machine or wood screws, bolts or nuts. Write for full information also about the Bosch High-Speed Electric Grinder.

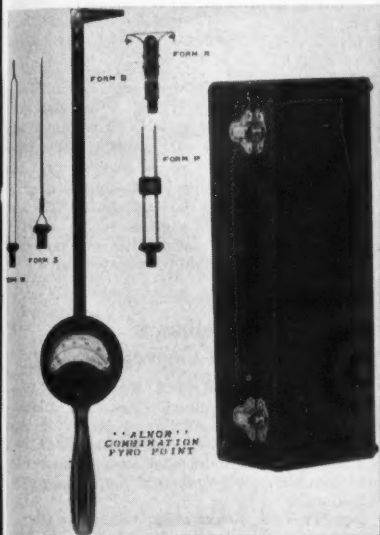


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BOSCH AUTOMATIC ELECTRIC SCREW DRIVER

can be revolved at 360 deg. and the thermo-couples can be attached or adjusted to one of several angles, thus making it possible to read temperatures in crevices or openings otherwise inaccessible. The thermo-couples can quickly be changed with the aid of a screw driver.

The standard Pyro Point has a scale range of 0-600 deg. F., although higher ranges can



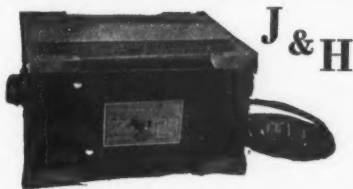
Alnor Pyro Point Surface Temperature Pyrometer

be furnished on special order. The instrument is furnished in a suitable carrying case which will accommodate both the instrument and the different thermo-couples used with it.

Johnston Variable Reducer

Infinite speed control from 0 to any desired speed can be obtained with the Johnson Variable Reducer, through the medium of a control that is visible and quickly manipulated. The mechanism is so designed that the unit stops instantly, having no high speed inertia to overcome. The reducer, which is a product of The Smith Power Transmission Co., 436 Penton Bldg., Cleveland, Ohio, is a single unit mechanical device in the design of which the well-known over-running clutch principle is incorporated.

The out-put speed ranges from 0 to 240 r.p.m. and for ranges above 240 r.p.m. a step-up drive can be used on the out-put shaft. The speed changes to the driven shaft are



The Demagnetizer For Alternating Current

THE J & H Demagnetizer requires no countershafts, belts, or other intricate electrical connections. All that is necessary is to plug it into the nearest lamp socket or receptacle.

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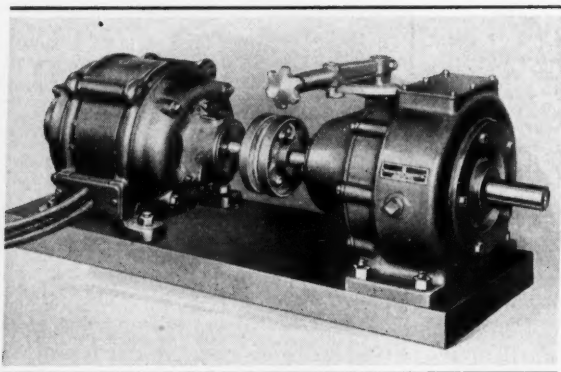


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Johnson Variable Reducer

accomplished by changing the stroke of the five arms attached to the one-way clutches. This change is made by a simple variable throw crankshaft arrangement controlled by the hand lever.

The unit is composed of five one-way over-running clutches, the clutches transmitting their power in uniform cycles to a centrally-mounted driven gear. The driven gear is

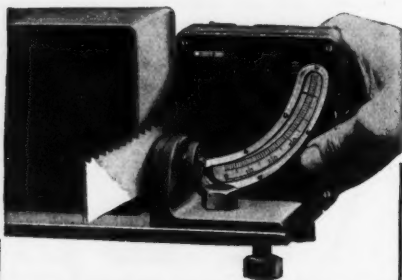
with a 1200 r.p.m. motor. The mechanism is completely enclosed and operates in an oil bath.

Reliance Type S Gearmotor

The Reliance Electric & Engineering Company, 1090 Ivanhoe Road, Cleveland, Ohio, is now offering a line of "gearmotors" in sizes rated from $\frac{3}{4}$ h.p. up. The gearmotor is a combination of motor and speed reducer in one compact, self-contained and fully protected unit.

The Type S gearmotor, shown in the illustration, is so constructed that a cartridge-type gear unit carries all gears and bearings except the high speed pinion and bearing. The cartridge can readily be removed without disturbing the alignment of any gears or bearings.

Power is transmitted through a train of helical gears which provide for quiet operation. The gear ratio can readily be changed by the user by changing the high speed pinion and gear, and by rotating the cart-



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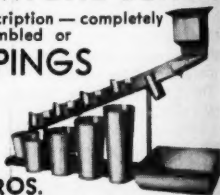
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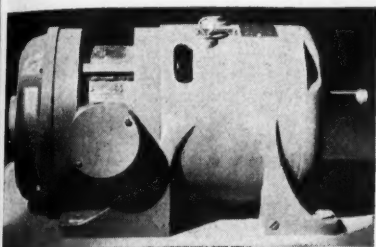
5 E. Third St.

Cincinnati, Ohio



ridge gear unit, from four to eight positions of the output shaft can be obtained.

A solid support for the unit is provided by substantial feet cast integral with the gear

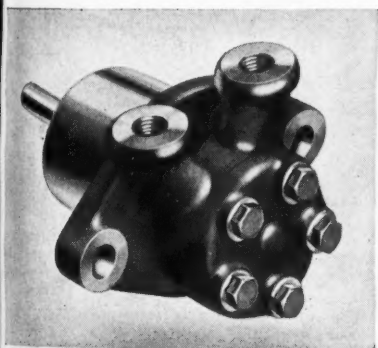


Reliance Type S Gearmotor

housing. The oil height is checked by an ordinary bayonet-type oil gauge. The gearmotor can be supplied for a wide range of ratios with both a.c. and d.c. motors of various types.

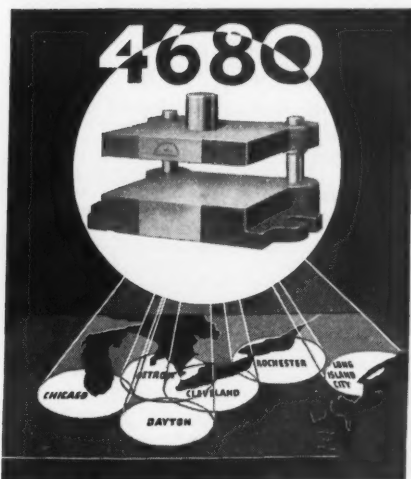
Sundstrand "Rota-Roll" Pump

The Sundstrand Machine Tool Co., Rockford, Ill., announces a new development in the "Rota-Roll" Pump, which can be supplied with either flange or foot type mounting for application to oil burners or for industrial in-



Sundstrand "Rota-Roll" Pump

stallations. The pumping mechanism operates in the manner of a ball bearing, with a rolling action which provides a rotary seal. As there are no sliding contacts, wear is reduced to the minimum and the mechanism is quiet at both low and high speeds.



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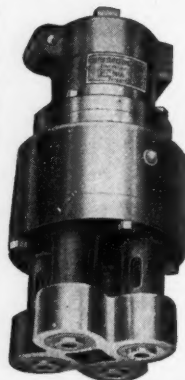
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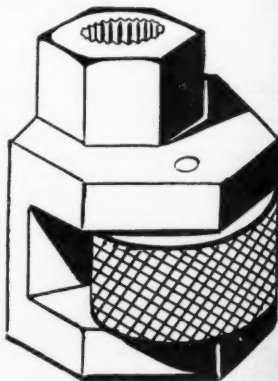
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The rolling seal obtained through the action of the roller and rotor is positive, and as the wear is uniform, the seal is maintained throughout the life of the pump. The roller and rotor are hydraulically balanced and self-emptying, which eliminates back-surfing and provides a positive, uniform flow. The capacity of the Rota-Roll Pump is 20 gallons per hour at 100 pounds pressure and at a speed of 1800 r.p.m. The pump is driven direct at motor speeds of either 1200 or 1800 r.p.m.

Zoerman-Clark Stud Remover

The illustration shows a tool with which studs can be removed without damaging the threads or otherwise injuring the studs so that they cannot be used again. The tool, which is a product of the Zoerman-Clark Mfg. Co. 809 S. Water St., Jackson, Michigan, consists primarily of two parts—the body of the tool, which slips over the stud that is to



Zoerman-Clark Stud Remover

be removed, and the knurled roller, which wedges against the stud and locks itself so tightly that the entire tool can be revolved with a wrench, carrying the stud with it.

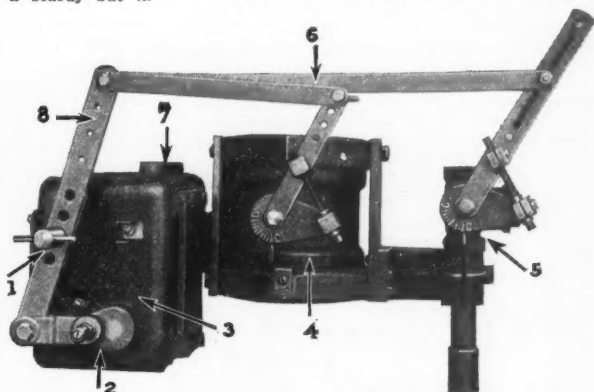
The knurled roller is eccentric; thus when locked in position against a stud, the greater the resistance offered by the stud, the tighter the tool grips. The design of the tool is such that the stud will break before the tool does, but as the purchase is applied close to the work, this tool will dislodge the stud without breaking it if it is at all possible. The tool is of high grade steel, hardened all over. The tool illustrated weighs one pound, and will handle studs from $\frac{1}{4}$ to $\frac{1}{2}$ in. diameter.

New Two-Position Motor Operated Controller

To meet the demand for a sturdy but inexpensive controller of the two-position type to operate one or more valves as a unit, a damper or a rheostat, the Automatic Temperature Control Company, Inc., 34 East Logan St., Philadelphia, Pa., has added to its line of motor-operated controllers a new unit known as Type 2, which has sufficient power to handle two valves up to 4-in. size as a combination with a 1/2-in. fuel oil valve or to handle two valves up to 4-in. size as a unit on low pressure gas and air.

Where furnace atmosphere is important, valves having similar characteristics are provided, each equipped with micrometer screw adjustment for minimum setting and with index and dial plate

to permit readily duplicating previous settings. Maximum settings for both fuel and air valves can be obtained by adjusting the connecting links (6) where attached to the valve levers,



Type 2 Two-Position Motor-Operated Controller

and where attached to the main operating lever (8). With the valves adjusted for desired combustion, the fuel-air ratio is main-

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HEAVY DUTY—EXTRA VALUE
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tained throughout controller stroke. Both valves are moved simultaneously and in unison—a desirable feature not possible where springs or lost motion linkage is employed.

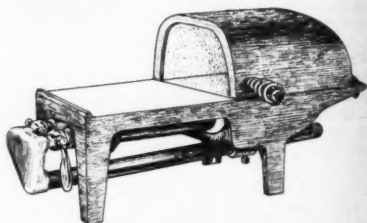
A feature which is standard with the Type 2 Controller is the ability to quickly remove the fulcrum stud (1), thus permitting the attendant to manually move the main operating lever, (8) with attached valves to any desired position. This feature is a convenience when starting up a furnace and it also eliminates the expense of by-pass piping and valves for the air line.

Where full pipe line capacity is required, and tight shut-off is essential, Type 2 Con-

troller can be supplied to operate valves of globe body type in sizes up to 3-in., for pressures up to 250 lb. per sq. in. Where the medium is at lower pressures, Type 2 Controller has sufficient power to handle larger valves of globe body type. These valves can be provided with an adjustment feature permitting any desired minimum setting up to 50 per cent of valve capacity.

Red Devil Gas Bench Furnace

A two-burner gas bench furnace in which a pair of 10-lb. soldering irons can be heated in five minutes, or in which small carbon steel tools, dies or parts can be heat-treated, is now being marketed by Red Devil Manufacturing Co., Bellwood, Ill. The furnace has a number of outstanding features, the



Red Devil Gas Bench Furnace.

principal one being that the firebox is lined with durable fireclay and that no blower is required to operate it.

The furnace is 15 in. long and 7 in. high, with a firebox that is 5½ in. long, 5 in. wide, and 4 in. deep. The furnace is intended to burn either manufactured or natural gas, the gas consumption being 15 cu. ft. per hour for each of the two burners. The burners are of the Bunsen type, and produce a fire box temperature of over 1800 degrees.

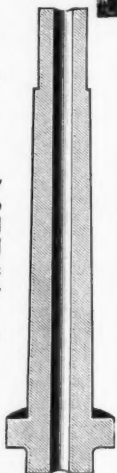
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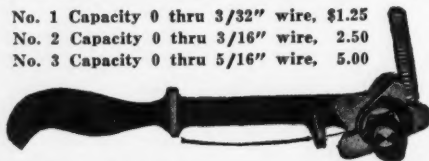
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HERE'S A REAL SPRING WINDER!

- No. 1 Capacity 0 thru 3/32" wire, \$1.25
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Will Earn Its Cost in One Day

The HJORTH Perfection Spring Winder offers the ideal means of winding extension, compression, torsion, taper, double taper, or left hand springs. Try one in your shop. You'll like it and the price is reasonable.

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"The Blade in the Plaid Box"



**There's a Bonus in Buying
Good Blades!**

Lenox blades pay users a big bonus in better workmanship—increased production—lower operating costs—cash saved. The hack saws that bear the name "Lenox" are guaranteed to be as good as experienced men and quality materials can make them. Their superior performance and uniformity make them very economical in the long run. Tear out this ad as a reminder to give Lenox Blades a trial. Your mill supply dealer has them.

AMERICAN SAW & MFG. CO.
Springfield, Mass., U. S. A.

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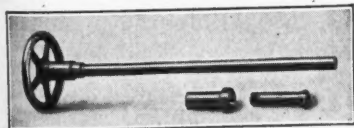


Speed Reducers,
Lathe, Shaper
and Milling
Machine Drives.

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CULLMAN WHEEL CO.

1336 ALTGELT STREET CHICAGO



Collet Attachments for your lathes and millers

Write for Bulletin No. 100 A. M.—
Rivett Draw-In Collets and Chucks.
Also Price List and Dimension Sheet.

Rivett Lathe & Grinder Corp.
Brighton Dist., Boston, Mass., U. S. A.

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Improvements

have been made in the
past three years in the

G S I P SWISS

JIG BORERS

They are made in

7 Sizes

Tell us the range of jobs you have to do and we shall gladly recommend the best machine and tell you of the changes that have been made in it.

THE R. Y. FERNER CO.

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The burners are mounted parallel with the fire box, forcing the flame to travel to the extreme end of the box where a curve in the box forces the flame upward around the tip of the soldering iron. The hood is also curved so that the flame is forced back over the iron. The hood is hinged and can quickly be removed when necessary. Full gas pressure to the burners is provided by a special large cast well manifold. The burner tips are easily adjusted, and are non-sticking.

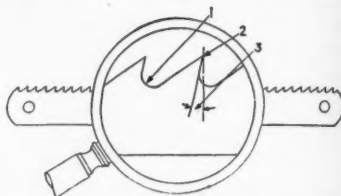
When using the furnace for heat treating tools or small parts, the fire box opening is practically closed by the use of an angle baffle plate which is supplied for this purpose. The construction of the burners is such that secondary air is introduced at the point where the burners project into the fire box. The furnace is designed to provide both efficiency and economy on small jobs.

Forsberg "Whale Brand" Hack Saw Blades

A hack saw blade with the teeth undercut, to be known as the "Whale Brand" blade, is now being marketed by The Forsberg Mfg. Co., Bridgeport, Conn. Claims made for the undercut tooth are that less pressure per stroke is required to operate a saw in which this blade is used, that it will

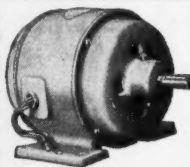
cut faster, and that the blade will last longer.

In undercutting the tooth, a large circular gullet is formed in which the chip is said to curl, thus preventing clogging of the tooth and precluding the possibility of breakage



"Whale Brand" Hack Saw Blades.

from this cause. The gullet is indicated at (1) in the illustration. The angle at which the tooth are undercut also provides clearance which aids the cutting operation, leaving a sharp-pointed tooth as shown at (2). The amount of undercut is indicated at (3). With clearance undercut in the tooth as shown, a maximum of speed in cutting can be obtained. The use of modern methods of manufacturing and heat treating makes it possible to guarantee uniformity in the quality of the blades.



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... embody every detail of simplicity, ruggedness, and dependability. Accurately built of finest materials. Sold with 5 year guarantee.

Single Phase Type:— $\frac{1}{2}$, $\frac{3}{4}$, and 1 H. P.
110/220 volt, 60 cycle, 1750 R.P.M.
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Write for details and prices.

EMERALD ELECTRIC CO., Adrian, Mich.



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MODEL 223

PYROMETER

For the Hardening Furnace

Price complete with-out protection tube. **\$35**

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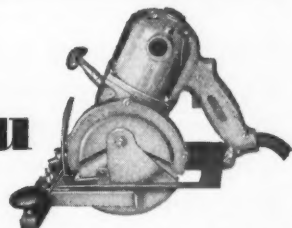
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Headquarters for free information and for making Solid or Inserted Tooth Circular Saws and Band Saws for cutting metal. Write us

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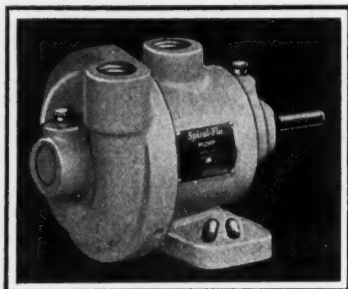
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Wall Chart for Belt Users Provides Useful Data

With the continual increased business activity of the past few months, many plant engineers are facing the problem of reconditioning idle belts and placing them back into service. Such engineers will find much useful information on a large 24x36-inch wall chart entitled, "The Care of Leather Belt."

THE CARE OF LEATHER BELT

E. F. HOUGHTON & CO.
"The Belt that Puts the Pull in the Pulley"
PHILADELPHIA, PA. And All Over the World

which is being distributed free by E. F. Houghton & Co.

Some of the subjects covered on this wall chart are:

- How and when to dress belt
- Belt fastenings.
- How to lace a belt.
- How to put on a belt.
- Tables showing the width of belt necessary for any drive.
- Mechanical rules for figuring speeds, pulley ratios, etc.

A copy of this large wall chart may be obtained without charge by addressing E. F. Houghton & Co., 244 W. Somerset St., Philadelphia, Pa.

Pratt & Whitney Issues Catalog of "Keller Burs"

Pratt & Whitney Company, Keller Division, Hartford, Conn., has issued a catalog of the burs made by this firm. Keller burs are made from three different grades of steel, each selected because of inherent qualities which make it valuable for a particular class of work. High carbon steel burs are used on mild steels and the softer metals such as bronze, brass, copper, aluminum, zinc, etc. High speed steel burs are used for the harder metals and in cases where unusually high spindle speeds are used. Mill-cut burs in general are made of semi high speed steel, for use on medium and soft metals and on a variety of non-metallic materials such as wood, rubber, bakelite, fibre, etc.

Keller burs are available in a wide variety of shapes, sizes, and cuts. Listed in the catalog are burs for practically any and all requirements, involving fine, medium, and coarse cuts, extra fine and extra coarse cuts, rasps, herringbone cuts, and others. The burs can be furnished singly or in sets as desired. Illustrations show 166 different types and styles of burs. A copy of the catalog will be sent free to any mechanical executive.

Bulletins on

Lincoln Track Welders

The Lincoln Electric Company, Cleveland, Ohio, has issued bulletins describing the Lincoln Quick-Removable Track Welder and the Lincoln Self-Propelling Track Welder. The Quick-Removable unit consists of a 200-amp. welder and an auxiliary generator, close-coupled type, direct connected to a gasoline engine. The welder has capacity to handle up to 1/4-in. electrodes at a distance as great as 125 feet. Take-off rails are provided for swinging the welder clear of the track when working.

The Self-Propelling unit is provided with a specially-designed driving motor so that the unit can be self-propelled at any speed from a walk to 30 or more miles per hour. With this 300-amp. welder, 1/4-in. electrodes can be used at a distance of 1,000 feet from the machine; thus it is possible to repair 2,000 feet of track at one derailling.

Copies of the bulletins are available to mechanical executives.

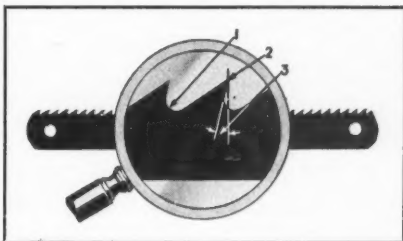
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Engineers—Machinists—Mfrs' Agents
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This Undercut Tooth
Saves Time. Increases
Life of the Blade.



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- 2 Keen, sharp edge insures long life.
- 3 Undercut tooth requires less pressure per stroke. Less number of strokes to cut piece.

The "Whale Brand" Hack Saw Blades feature an Undercut Tooth which assures faster cutting, longer life and less breakage.

The Undercut Tooth is manufactured under a patented process.

Modern machinery and proven methods make certain that each and every Whale Blade is uniform in quality.



Send For Trial Blade

Try this blade in your own shop. We will gladly send a sample blade to department heads and executives writing on their company stationery. See for yourself how the undercut tooth saves time and increases the life of the blade.

"Whale Brand"

The Hacksaw Blade with the undercut tooth.

THE FORSBERG MFG. CO.
BRIDGEPORT, CONN.

For Your Catalog Library

Check any of these useful publications that you want, write your name, firm name, title, and address on the margin, then tear out the page and send to Modern Machine Shop, 128 Opera Place, Cincinnati, Ohio. They will be forwarded to you promptly without cost or obligation. Please restrict your list to not more than five.

Pulleys of high grade aluminum alloy, accurately machined, are described and illustrated in a bulletin that can be had by addressing **Adrian Foundry & Machine Co. Inc., Adrian, Mich.**

Lubrication by Barrel-To-Bearing System: The most modern system of lubrication for machine tools is described in a folder that can be had by writing to **Almenite Corporation, 2680 N. Crawford Ave., Chicago, Ill.**

Chucks—Key and Keyless: Bulletin No. 120A, 632, and 633, issued by **T. R. Almond Mfg Co., Ashburnham, Mass.**, describe and illustrate the line of key and keyless geared nut and ball bearing drill chucks made by this firm. Copies free upon request.

Cut Your Sawing Costs: "Lenox" hack saw blades and band saws are guaranteed to effect savings on your sawing operations. Write for information to **American Saw & Mfg. Co., Springfield, Mass.**

Stop Tap Breakage: A booklet that tells how to stop the breakage of taps, reamers, and other tools, by the use of a friction chuck, also how to use the chuck for setting studs or nuts, has been issued by **The Apex Machine & Tool Co., 200 Davis Avenue, Dayton, Ohio.** Sent free upon request.

"Atlas" Bench Lathe: A 9-in. screw cutting, self-contained, motor-driven bench lathe is now being built by **Atlas Press Co., Kalamazoo, Mich.** Write for circular.

Irregular contours on dies or tools can be finished accurately and fast by the use of the No. 2 **Baker Grinder.** Write **Baker Brothers, Inc., Toledo, Ohio,** for descriptive bulletin.

Drop Forged Steel Die Sets: The economy and other advantages of drop forged steel die sets, which are now being made by **E. A. Baumbach Manfg. Co., 1806 South Kilbourn Avenue, Chicago, Ill.**, are explained in a folder that can be had by addressing this firm.

Bushings and Bearings: 500 sizes of finished bronze bushings that are available immediately are shown in a catalog that can be had by writing to **The Bunting Brass & Bronze Co., Toledo, O.**

Comtorplugs: Interchangeable plugs for internal gaging, from 0.250 in. to 8 in. dia. and up to 24 in. in length, graduated by an amplifier to 0.0001 in., are described and illustrated in a circular that has been issued by **The Comtor Company, Waltham, Mass.** Copy free upon request.

Motorize Your Cone Pulley Lathes: An attachment that can be applied to your lathe with four bolts makes it possible to motorize an modernize your lathes. Write for information to **Cullman Wheel Co., 1336 Altgeld St., Chicago, Ill.**

Die Makers' Supplies: A complete line of die sets, leader pins, bushings, and other die makers' supplies are described in a book that is issued by the **Danly Machine Specialties, Inc., 2104 South 52nd Avenue, Chicago, Ill.** Sent free upon request.

"Speed" Spot Welders for welding metals from 0.0005 in. to $\frac{1}{2}$ in. thick are described in a catalog that can be had by addressing **Eisler Electric Corp., 761 South 13th Street, Newark, N. J.**

Better Supervision: Write to **Elliot Service Company, 242 West 55th St., New York, N. Y.** for a free sample copy of "Management"; an information service for plant executives and department heads, based upon actual shop problems and factory experiences.

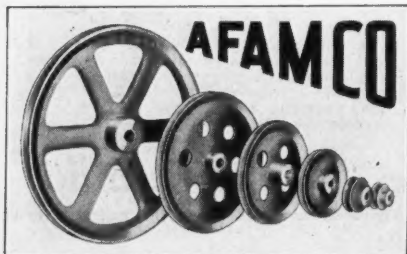
Emerald Motors are designed for simplicity, ruggedness, and dependability. Three sizes: $\frac{1}{2}$, $\frac{3}{4}$, and 1 h. p. Write **Emerald Electric Company, Adrian, Michigan,** for bulletin.

Performance Data On Swiss Jig Bore: This 36-page pamphlet shows various types of jobs from a power shawl turntable jig to a television disc, drilled and bored on **Societe Genevoise High Speed Precision Bore**s, giving data as to size of holes, accuracy and time savings. Free upon request to **The R. Y. Ferner Co., 1008 K Street, N. W., Washington, D. C.**

Secret of Fast Cutting: Use a hack saw blade with the correct tooth-clearance angle so that the metal will be cut—not pushed. Full information can be had by asking **Forsberg Manfg. Co., 123 Seaview Ave., Bridgeport, Conn.,** for bulletin on "Whale Brand" Hack Saw Blades.

Formica Silent Composition Gears: A booklet telling about the uses and advantages of **Formica Silent Shock-Absorbing Gears**, and containing a fund of valuable data with rules and tables for laying out, cutting, and using gears can be had by addressing **Formica Insulation Co., 4632 Spring Grove Ave., Cincinnati, O.**

Tool Grinding Costs can be cut by using the "Economy" face milling cutter. Write to **J. E. Freyman & Sons, 3627 Keswick Road, Baltimore, Md.,** for information.



Pulley Values

AFAMCO Pulleys of high grade cast aluminum alloy are stronger, properly balanced, and attractive in appearance. All grooves and bores are accurately machined.

Single groove pulleys in sizes to and including 12" diameters, and 2, 3, and 4 groove step pulleys.

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ADRIAN FOUNDRY & MACHINE CO., INC., ADRIAN, MICH.

Stampings of any kind or size can be obtained from Gerding Brothers 5 East Third Street, Cincinnati, Ohio. Write for particulars.

Ball and Roller Bearings, either journal or thrust, for all purposes and all sizes, are described and illustrated in catalog No. 9 which has been issued by The Gwilliam Company, 360 Furman Street, Brooklyn, N. Y. Copy free upon request.

Precision Bench Lathe Work can only be done on finely-built, accurate machines. The complete line of Horth Precision Bench Lathes is described and illustrated in a catalog that has been issued by Horth Lathe & Tool Company, 60 State Street, Boston, Mass. Copy free upon request.

Pyrometers: Inexpensive portable and stationary, single unit and multi-circuit pyrometers are described in a catalog issued by Illinois Testing Laboratories, Inc., 146 West Austin Avenue, Chicago, Ill. Copy free upon request.

Oil and Waterproof Chucks: The J & H Electric Co., 202 Richmond Street, Providence, R. I., is now making a chuck that is oil and waterproof, and is designed to provide a maximum of holding surface with exceptionally strong and uniform pull throughout. Ask for complete information.

Dress Your Grinding Wheels Better, in less time, with less waste of wheel and diamond by using Koebe Multi-Point Diamond Dresser. Write Koebe Diamond Tool Co., 1200 Oakman Blvd., Detroit, Michigan, for details.

Do you buy the same cutter over and over again? Every time you grind a cutter on an old-fashioned time-wasting cutter grinding machine, you are paying for new cutters that you never get. Let the Landis Tool Company, Waynesboro, Pa., tell you how to save this money. Write today.

Air-Operated Work-Holding Devices: A booklet showing how air-operated chucks and devices of various kinds can be applied to different kinds of machines to save time and labor has been issued by the Logansport Machine Co., Logansport, Ind.

Compound Spot-Facing Tool: A spot-facing tool extracting, serrated roughing cutters and fixed finishing cutters in the same tool will break up the scale easily and do accurate work. Write for bulletin to Mummert-Dixon Co., 120 Philadelphia St., Hanover, Penna.

Ball and Roller Bearing Data Sheets: A complete set of data sheets showing all the dimensions and loads at given speeds, and giving instructions for mounting precision ball bearing and Hoffmann roller bearings, can be obtained without charge by addressing the Norma-Hoffmann Bearings Corporation, Stamford, Conn.

"Commercial Lapping for Close Limits and High Production" is the title of a booklet that discusses hand and machine lapping, types of lapping tools and machines workholders for machines, preparation of laps, preparation of work for lapping and other important points. A copy may be had by addressing Norton Company, Worcester, Mass.

Die Making Machines: How dies, templates, gages, etc., can be saved out, filed, and lapped

easily and accurately on Oliver die making machines is fully described in a bulletin issued by the Oliver Instrument Company, 1430 Maumee Street, Adrian, Mich. Mailed upon request.

Good Gears of all kinds—spur, spiral, bevel, worm, hypoid—in fact any kind or type of gear desired, large or small, machined to an excellent finish and the highest degree of accuracy, may be obtained from Perkins Machine & Gear Co., 151 Circuit Ave., Springfield, Mass. Write for estimates.

Flat Steel Wire to Meet Specifications of the most exacting buyers is now being made by John A. Roebeling's Sons Company, Trenton, N. J. Send your specifications and ask for prices.

Steel Stamps and Marking Dies: Full information as to steel stamps, steel roller dies, embossing dies, and embossing rolls made by the Schwerdtle Stamp Co., 10 Cannon Street, Bridgeport, Conn., can be had by writing this firm.

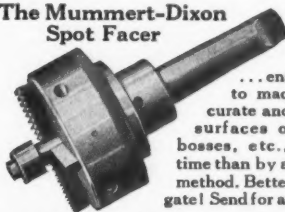
Simonds Files: A useful book on files showing the various styles made, their uses, cross-section, and cuts, and containing a number of reference tables and other information useful in a machine shop can be had by addressing Advertising Dept., Simonds Saw & Steel Co., 470 Main Street, Fitchburg, Mass.

An Electric Hand Shear will save time, material, and labor on jobs that are too small, too large, too complicated, or too cumbersome to be handled in the power shear. Ask The Stanley Electric Tool Co., New Britain, Conn., for catalog.

You can harden and temper tools and small parts correctly and economically by using an "Electroblast" high speed muffle furnace. Ask Stark Tool Company, Waltham, Mass., for complete information and details.

A Visible Record of Performance of your machines will enable you to keep check on the production of each unit. Ask Stewart-Warner Corporation, 1826 Diversey Parkway, Chicago, Ill., for the booklet on, "Tachometer Application To Industrial Machines."

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